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SOME ANATOMIC DETAILS OF IMPORTANCE IN OCULAR SURGERY

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In few organs of the human body does one find such complicated, highly differentiated structures, with such a wealth of minute detail, as in the eyeball. At the same time the topographic relations vary not only in different persons, as is evidenced by the difference between an eye of more elongated structure and an eye constructed on shorter lines, but even in one and the same eye on different occasions—for instance, according to the width of the pupil, the thickness of the iris, the size of the lens or the age of the person.

For the ophthalmic surgeon the topographic relations are of paramount importance. It has been my observation that in spite of the many excellent books on the normal and the pathologic anatomy of the eyeball errors are of frequent occurrence. It is eminently necessary that the surgeon who operates on the eye shall be above all else thoroughly familiar with the structure of the cornea and with the peculiar consistency of the corneal tissues.

THE CORNEA

The cornea consists histologically of five layers, namely, the stroma, the anterior elastic layer (Bowman's membrane), the posterior elastic layer (Descemet's membrane), anteriorly the epithelium and posteriorly the endothelium. Of equal importance for the surgeon and for the clinician is the differentiation between Bowman's membrane and Descemet's membrane, whereas a knowledge of the epithelium and the endothelium is of more importance for the clinician.

While it may not appear that I am called on to discuss in detail the differences in the aforementioned structures, it seems well to recall some of the more important anatomic features.

1. Bowman's membrane is developed embryologically from the outermost layer of the corneal lamellae; hence it is very intimately associated with these and cannot be readily dissected from the stroma, whereas

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Descemet's membrane, being an outgrowth of the endothelium, is not firmly attached to the stroma and can be easily separated from it.

2. In view of the facts just stated, a regeneration of Bowman's membrane once destroyed is impossible, whereas Descemet's membrane can be formed again from the endothelium.

3. Descemet's membrane is more resistant to external influences than are the other corneal tissues.

4. Bowman's membrane resembles elastic tissue, although it is not that, whereas Descemet's membrane is extremely elastic. This may be seen on examination of anatomic preparations of injured corneas. The margin of Descemet's membrane curls up and in the vicinity of the wound it wrinkles, but these phenomena do not occur in Bowman's membrane.

That Descemet's membrane is easily detached (fig. 1 *A*) is a fact of which the surgeon must take careful account. It should be emphasized that Descemet's membrane may be readily detached not only by fluids, infiltrates and tumors but also by contact of instruments.

Detachment of Descemet's membrane resulting from surgical procedure is extremely frequent, as is revealed by observations with the slit lamp.[1] Usually it occurs when the iris is replaced with a spatula during iridectomy for glaucoma. The operator fears lest he inadvertently come in contact with the lens and injure it, and so he directs the spatula more toward the cornea. In this way he may introduce the spatula between Descemet's membrane and the stroma. At first he meets with resistance, and only after he has unconsciously lacerated Descemet's membrane is he able to move the spatula more freely. Later on, with the slit lamp he may see a cone-shaped detachment of Descemet's membrane, and often he can distinguish a good-sized shred of this membrane stripped backward in the anterior chamber.

Such a case is illustrated in figure 1 *A*. It occurred in a man aged 30 who had been troubled with a diseased eye for eight years and who had undergone an iridectomy to prevent seclusion of the pupil. Descemet's membrane (*d*) is detached for a considerable distance and lies rolled up on itself on the anterior surface of the iris (fig. 1 *B*). One sees the curled-up membrane (*d*), which is held in position by fine connective tissue cells. The iris is highly infiltrated and shows nodules of lymphocytes. The pigmented epithelium (*p*) is partially disorganized and is attached to the capsule of the lens (*l*) by a thick membrane. The inner surface of the lens is calcified (*c*).

Clinically, no great harm is done by detachment of Descemet's membrane. Strange to say, in hydrophthalmos and keratoconus there devel-

1. Sallmann: Verhandl. d. Wien. ophth. Gesellsch., 1924-1925, p. 66. Samuels: Tr. Am. Ophth. Soc. **26**:427, 1928. Arkhsangelskaya: Sovet. vestnik oftal. **5**:546, 1934; abstr., Zentralbl. f. d. ges. Ophth. **33**:451, 1935.

ops in association with a laceration of Descemet's membrane very marked acute edema of the cornea, which manifests itself by the sudden appearance of a porcelain-white clouding of the cornea. Later this

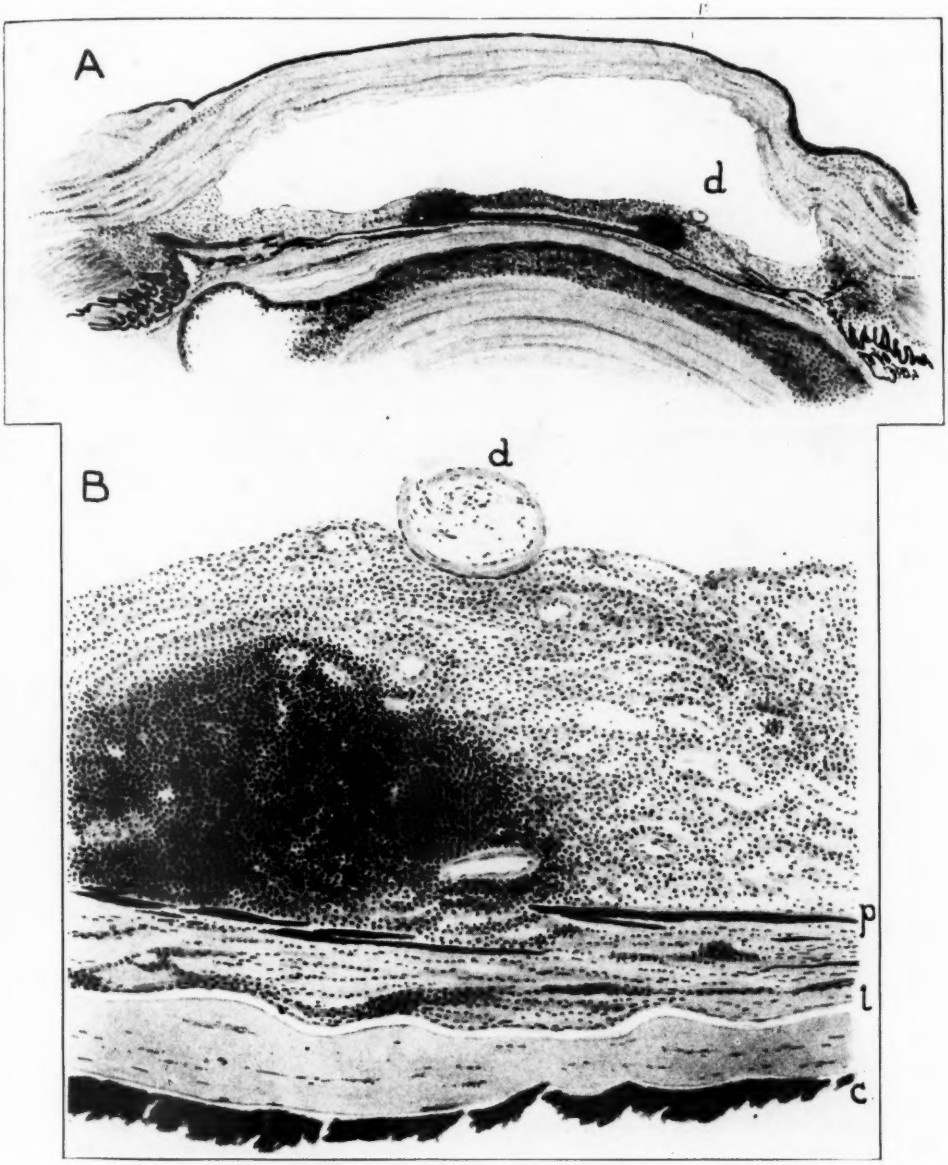

Fig. 1.—Detached Descemet's membrane: *A*, general view; *B*, detailed view. In this figure *d* designates the detached membrane; *p*, the pigmented epithelium; *l*, the capsule of the lens, and *c*, the calcified inner surface of the lens.

partially disappears, and one can see the laceration of Descemet's membrane, with the edges rolled up on both sides. Such marked clouding of the stroma does not occur in connection with operative detachment—

just why is not known. At most the portion of the cornea overlying the region of the detached membrane is somewhat lusterless, with possibly a trace of cloudiness.

Detachment of Descemet's membrane in connection with cyclodialysis is especially frequent and is not difficult to understand. In applying the spatula, the instrument is held as close as possible to the sclera and cornea and it often meets with resistance, which one is in the habit of overcoming. Often, however, the resistance does not come from the anterior peripheral synechia (the adhesion of the root of the iris to the ligamentum pectinatum), as one may be inclined to think, but is due to the fact that one has touched Descemet's membrane and finds it difficult to advance the spatula. As one moves the instrument back and forth, Descemet's membrane becomes detached, and this is revealed later by clinical examination. The occurrence is made more likely by the presence of the so-called anterior marginal ring of Schwalbe (fig. 2 *A*). The internal scleral sulcus (*s*) in which Schlemm's canal lies and which is bridged over by the pectinate ligament is bordered posteriorly by the posterior marginal ring (*p*), a transverse section of which is called the scleral spur, and anteriorly by the anterior marginal ring (*a*). The latter is often barely present as such, but sometimes one finds in histologic sections at the margin of Descemet's membrane (*d*, fig. 2 *B*) a circular bundle of connective tissue, which may attain considerable size but which never, apparently, forms a complete ring, being demonstrated only as broken portions of a ring. Such an anterior marginal ring (*a*, fig. 2 *B*) constitutes an obstacle to advancement of the spatula in cyclodialysis, and during the operation it may become detached along with Descemet's membrane. This assumption based on a study of histologic preparations I [2] was able to confirm at once clinically in a patient with chronic glaucoma following cyclodialysis. Extensive partial detachment of Descemet's membrane had occurred, and at the margin of the membrane a shining tendon-like strip, the anterior marginal ring, was distinctly visible with a slit lamp.

Detachment of Schwalbe's anterior marginal ring is of no clinical importance, but the surgeon should realize that he will often have considerable resistance to overcome, which is not, however, a serious matter. All that is necessary to do is, immediately after the appearance of the point of the spatula behind the limbus, to direct it upward and then pull it backward in order to get it out of the pocket in front of Descemet's membrane.

In this connection, perhaps I may be permitted to call attention to another experience that happened to me twice in connection with cyclodialysis. The first time I could not fully understand the occurrence and not until later did the cause become apparent. I was assisting a beginner

2. Fuchs, A.: Ztschr. f. Augenh. **67**:129, 1929.

to perform this operation. In accordance with proper technic he was advancing the spatula, pressing it along the inner surface of the sclera, toward the anterior chamber. I perceived, however, that the point of

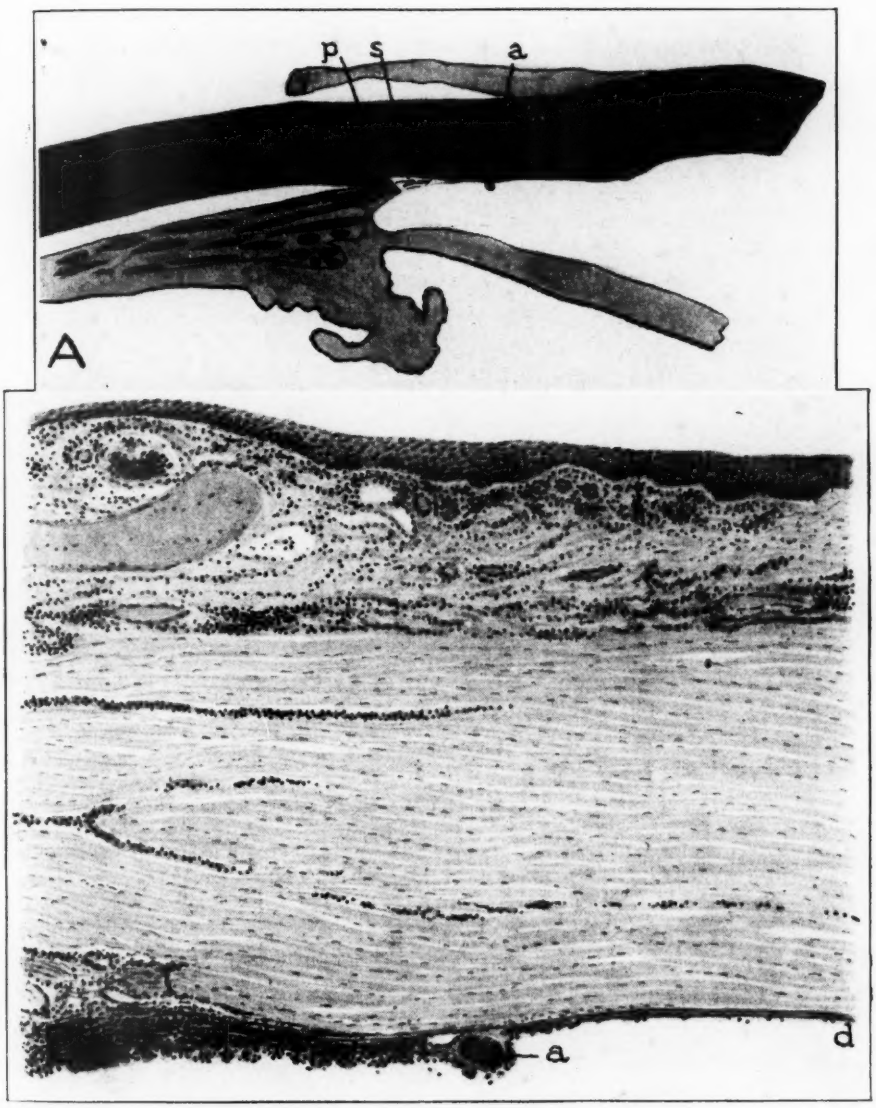

Fig. 2.—Schwalbe's ring: *A*, diagram; *B*, magnification. In this figure *p* designates the posterior marginal ring; *s*, the internal scleral sulcus; *a*, the anterior marginal ring, and *d*, Descemet's membrane.

the spatula did not appear in the anterior chamber but that suddenly the periphery of the iris was pushed toward the cornea. I said quietly: "Draw the spatula out again, very cautiously, holding it pressed against

the sclera." Then I completed the operation, encountering a slight resistance as I pushed the spatula forward, but the tip of the spatula appeared as usual in the anterior chamber, and separation of the ciliary body was easily accomplished. At first I had grave fears for the eyeball. I thought that possibly the spatula had pierced the ciliary body and had been advanced by the inexperienced operator along the inner surface of the ciliary body toward the posterior surface of the iris. I feared severe hemorrhage, followed by inflammation, due to injury of the ciliary processes, and loss of the eyeball, but nothing of the kind took place.

The explanation of this occurrence seems to be this (fig. 3): The scleral spur protruded somewhat; the root of the iris was closely attached and atrophic. The spatula had glided from the subchoroidal space (*ss*) on over the scleral spur (*s*) and had pierced the root of the iris (*r*)

Fig. 3.—Peripheral anterior synechia. In this figure *ss* designates the subchoroidal space; *s*, the scleral spur; *r*, the root of the iris, and *p*, the posterior chamber.

and entered the posterior chamber (*p*) without touching the ciliary processes. As it advanced farther it had pressed the iris from behind the cornea.

The ease with which Descemet's membrane becomes detached has a bearing on other operative procedures, particularly the Sonderman trephining for ulcus serpens cornea. A few years ago I reported [3] my experience with this therapeutic procedure, which in my opinion is excellent. It appears, however, that there is some hesitancy in accepting it, although it seems to me to give better results than other therapeutic methods—to be sure, only in case it is properly applied. In applying the trephine to either incipient or advanced ulcus serpens in the pupil-

3. Fuchs, A.: Brit. J. Ophth. **17**:193 (April) 1933.

lary region, a hole is bored with a 1 mm. trephine through the base of the ulcer or, if possible (and much better), through the progressive margin. This effects excellent drainage not only of the anterior chamber but also of the cornea, in which the direction of the lymph current is reversed and the toxins are no longer diffused toward the margin of the cornea but are swept into the trephine opening, which must be kept clear for several days. The great advantage of the procedure lies, when ulcus serpens is incipient, in the very small scars that result and in the degree to which visual acuity is preserved, and, when the condition is severe, in the surprisingly rapid disappearance of the commonly acute and enduring symptoms of irritation. An absolute prerequisite for the operation, which in itself is not difficult, is that it must be performed with great caution. Injury of the lens must under all circumstances be avoided. If the lens becomes injured the eye is lost, since endophthalmitis will develop. Possibly the procedure has become discredited because it has been used for ulcus serpens in eyes with glaucoma absolutum. For such a condition it is not suitable, since, with the sudden evacuation of the aqueous, the capsule of the lens may rupture spontaneously, which will bring about loss of the eye. The procedure is suitable, therefore, only for eyeballs that aside from ulcus serpens are normal and present no increase in tension.

It may happen that when one applies a trephine to an eye with advanced ulcus serpens one cannot easily penetrate the cornea with the instrument. Only by pressing hard enough will one succeed in penetrating the cornea, but at the same time one will enter the lens. With light and cautious pressure the trephine does not go through the cornea. This is my explanation: In many cases of ulcus serpens there is an infiltration of the anterior surface of Descemet's membrane by leukocytes. Such an infiltration may develop into a "posterior abscess" (*a* in fig. 4*A*). Naturally, Descemet's membrane in this region is separated by the pus from the stroma of the cornea. If the trephine now penetrates the cornea, the sharp edge presses back the more resistant Descemet's membrane without penetrating it and thus produces detachment of the membrane. It is then advisable not to advance the trephine farther but to take a sharp needle (for example, a discission needle or a Graefe knife) and perforate Descemet's membrane obliquely through the trephine opening. This can be accomplished because the membrane is easier to penetrate obliquely; then, too, this obviates the danger of injuring the lens. Of course, the aqueous does not gush out as fast as it would if a 1 mm. perforation with the trephine had been made. Nor is the hypopyon immediately washed out; but after twenty-four hours, when the bandages are again changed, one will usually find the chamber abolished and the hypopyon removed. The lips of Descemet's membrane

evidently roll forward into the trephine opening of the cornea and prevent a closure of the opening although it is very small. A knowledge of these conditions is important for the treatment of ulcus serpens by the Sonderman trephining and will prevent bad results.

Happenings similar to these may occur in connection with the Elliot trephining, namely, when the trephining is done too near the cornea

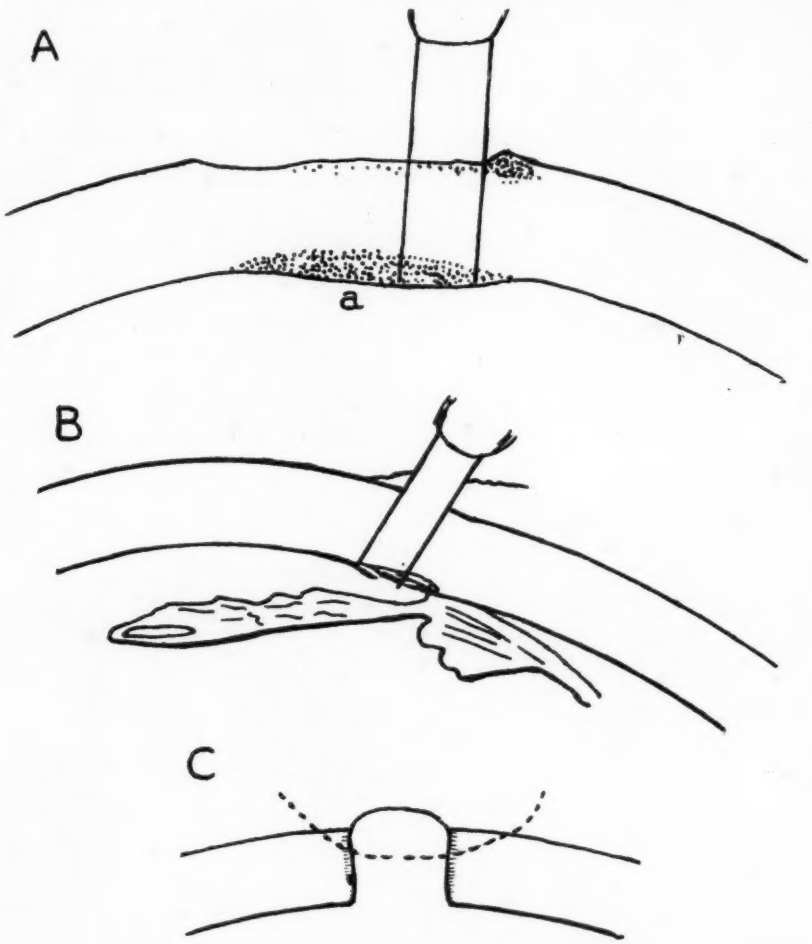

Fig. 4.—Difficulties occasioned by Descemet's membrane: *A*, Sonderman's trephining for ulcus serpens (*a* indicates an abscess with pus separating the membrane from the stroma); *B*, trephining if the peripheral rim of the trephine is outside and the central rim inside the margin of Descemet's membrane; *C*, descemetocele (the broken line indicates the region which must be included in the cauterization).

or when Descemet's membrane extends farther peripherally than usual. Under these circumstances the operator has the impression that the trephine has penetrated the cornea, but he seeks in vain for the appear-

ance of any protruding vesicle of iris. The scleral flap is removed, and he sees a dark background through the trephine opening, but it is impossible to advance the trephine so far that the iris protrudes. This impossibility, to be sure, concerns only the cautious operator, for the careless operator will bear down hard and thus force the trephine to penetrate the protruding Descemet's membrane, and at the same time it will go through the iris and injure the lens.

The cause of this occurrence lies doubtless in the fact that the periphery of Descemet's membrane is relatively easily detached since it is not so firmly united with the cornea as is the center. At the periphery, endothelial cells that accompany the various trabeculae of the pectinate ligament become interposed between Descemet's membrane and the lamellae of the cornea. Although Descemet's membrane becomes easily detached from the cornea, the trephine frequently is not sharp enough to penetrate this very resistant and tough membrane. In such a contingency my practice is to make an oblique incision with a keratome from the periphery through the trephine opening and toward the anterior chamber, which enables me to complete the operation easily. Thus one gets a combination of a keratome and an Elliot incision.

This may be the proper occasion to discuss a further unpleasant complication of the Elliot trephining and to explain its anatomic basis. It happens occasionally [4] during the trephining that fluid oozes through the trephine opening but that the iris does not protrude in the form of a vesicle. In that event, one cannot cut out the iris, because one cannot put a cutting forceps through the opening into the eye. Even to put in a small hook would be dangerous. If one leaves the opening as it is and covers it only with the prepared flap of connective tissue a good result is often secured and there are no further complications. However, frequently at the end of the first or second day one discovers under the flap of connective tissue a small dark-colored vesicle of iris, which one must excise, since, through the protrusion of the iris, all fistulization ceases and the danger of late infection is increased. Therefore, one is compelled to enlarge the trephine opening with an incision extending from the periphery, parallel with the limbus, into the anterior chamber. Then the iris will usually protrude and can easily be cut out.

The anatomic cause of this absence of the desired protrusion of the iris after the completion of the trephine opening may be explained in two different ways:

1. It may happen that the trephine is placed so that the peripheral rim of the trephine lies outside of the margin of Descemet's membrane

4. With a 2 mm. trephine all these complications will occur less frequently. I consider, however, the 2 mm. trephine opening too large and much more likely to produce late infection than the 1.5 mm. opening (following therein the usage on the continent), and I reserve the 1.5 mm. trephine for glaucoma.

while the central rim of the trephine lies within the membrane (fig. 4 *B*). If the operator proceeds cautiously (and he must do so if injury to the lens is to be avoided) the peripheral rim of the trephine cuts through the trabeculae of the ligament, but Descemet's membrane, offering resistance, cannot be cut through when only half of the trephine is placed over the membrane. A small opening is made that permits the escape of fluid, but this is not large enough to cause the iris to bulge forward. Continued turning of the trephine will accomplish little, for turning alone will not cause it to cut through Descemet's membrane, and pressure on the eyeball, which has already become soft, is contraindicated by reason of the lens.

2. It may happen that the root of the iris has become adherent to the pectinate ligament and to the posterior surface of the cornea, as in cases of long-standing glaucoma. This is important to bear in mind in connection with iridectomy ab externo (Salzmann [5]). If, making a hole in the sclera with the trephine, one immediately cuts through the iris, which may be entirely atrophic and consist possibly of only the pigmented epithelium, the fluid runs out of the posterior chamber, but no vesicle of the iris appears. Enlargement of the incision is of no aid. In one case in which I encountered this complication in iridectomy ab externo I resorted to cyclodialysis in the region of the operative incision in order to get the iris free from the periphery. I did not, it is true, succeed in freeing the iris and causing it to protrude, but I did succeed in freeing the angle of the anterior chamber and producing a fistulous scar. The case was unusual because the patient had had for four weeks an acute attack of glaucoma affecting both eyes. Profiting by this experience, I performed cyclodialysis in the other eye. Both eyes reacted to the operation as well as could be expected considering the difficulties of the situation.

If glaucoma is far advanced, the iris is much changed and one must expect a wide anterior synechia; possibly cyclodialysis will be the least dangerous and the most promising operation. Any one who has examined with the microscope eyes which have long presented the appearance of an acute attack or which in fact are in a condition not far removed from status glaucomatosus absolutus will know that often the iris has become to a great extent necrotic.[6] Clinically, the necrosis can be recognized in later stages by the iris assuming the appearance of blotting paper, which it does through the fading of the pigment in the chromato-

5. Fuchs, A.: Surgical Treatment for Iridocyclitis, Arch. Ophth. **11**:591 (April) 1934.

6. The clinician always designates the condition described as atrophic, but in the presence of glaucoma this is usually incorrect, since necrosis occurs, with disappearance of the sphincter, obliteration of the blood vessels and the like.

phores and the pigmented epithelium. This characteristic appearance of the iris is not present in eyes that have been only several days under the influence of an acute attack, but it becomes clinically observable later, and likewise the fading out of the pigment is easily visible with the slit lamp. The necrosis of the iris is, however, the cause of its marked lacerability, and in connection with this difficulties arise not only in ordinary iridectomy but also in all other operations in which the iris must be seized and excised. Therefore, if glaucoma is far advanced cyclodialysis, which is not generally employed if the condition is acute, is preferable.

Microscopic examination of eyes affected with glaucoma absolutum reveals also that the tissues of the iris in the region of the anterior synechia have often entirely disappeared, and that the ligamentum pectinatum, as a result of the heavy pressure, is compressed flat and is covered only by a layer of pigment, all that remains of the iris. No good results can then be expected from an operation, and it is best to omit operation for glaucoma entirely, since very frequently even the best operator will experience a spontaneous rupture of the capsule of the lens, which later leads to exceedingly unpleasant complications and finally may make enucleation of the eye necessary.

I mentioned that Descemet's membrane is much more resistant to chemical influence than the cornea or Bowman's membrane. In necrosis as the result of treatment with caustic agents and in ulcers one often sees the whole corneal stroma melt away, as it were, and finally there remains only Descemet's membrane, shining like silk, as a soft covering of the iris and as the anterior border of the capsule of the eyeball.

The operator has to deal with this fact in connection with descemetocele. In ulcerous processes Descemet's membrane begins to protrude as a small black vesicle at the base of an ulcer. If the attending surgeon has neglected by the application of a pressure bandage and the prescribing of rest in bed to press back the membrane and promote normal scar formation, the advancing descemetocele will become fixed by a whitish ring of scar tissue, in which it will appear as a slightly protruding black vesicle. Then a pressure bandage will no longer aid, because the membrane is already firmly adherent to the walls of the perforation.

Only cauterization will help—which must include about half of the thickness of the cornea and descemetocele (fig. 4 *C*). There will be no anterior chamber afterward, but the iris does not generally wedge itself in, as the canal is small and its margins are very smooth, being lined by Descemet's membrane. One should dust bismuth tribromphenate on the cauterized area in order to bring about as rapid a closure as possible and restoration of the anterior chamber. A tight-

fitting bandage is applied, and the patient is ordered to lie quietly in bed for a few days. After a few days scar formation begins, which is now no longer hindered by the protruding descemetocele, and a normal closure of the canal is brought about.

THE ANGLE OF THE ANTERIOR CHAMBER

The most important region for the operator is the angle of the anterior chamber. The majority of the interventions, ranging from puncture and extraction of foreign bodies to operations for cataract and glaucoma, and nearly all incisions originate in the vicinity of the limbus and extend from here into the angle of the anterior chamber.

The anterior boundary of the angle of the anterior chamber is the transparent cornea and the opaque sclera; the posterior border is formed by the ciliary body and the root of the iris. The entire space cannot, therefore, be surveyed from the front. Only when one looks obliquely can one see into the deeper part of the anterior chamber. In figure 5 the sclera is dark-colored while the cornea is lighter, and one can see how the sclera protrudes over the cornea (*l* and *s*). Since the sclera is opaque, one cannot survey the angle. This fact is of prime importance for the surgeon and for the clinician. A hemorrhage in the anterior chamber cannot be perceived until it attains a certain height. A very small hyphemia will remain invisible if the chamber is inspected from in front. But if one looks into the chamber from above, one will possibly observe a very small but clinically important hemorrhage. The examination from above is especially important owing to the possibility of discovering a hypopyon. A very small ulcer in the cornea has an entirely different clinical importance if a hypopyon is present, be it ever so small, since one may then recognize the ulcer as a very dangerous progressive lesion, and one may possibly reach the diagnosis of ulcus serpens. In such an event, inspection of the angle of the chamber from above should never be neglected.

The depth of the angle of the chamber varies considerably. The depth of the anterior chamber changes with the position of the lens and the iris, and corresponding changes are effected in the angle of the chamber. This is of clinical importance. A hyphemia that with normal depth of the anterior chamber has remained hidden behind the limbus may become visible when from any cause, for example, through oozing out of aqueous, the anterior chamber, and with it the angle, has become shallow. This does not happen so infrequently after operations. For instance, an eye may look fine after an operation for glaucoma. The next day one may find an extensive hyphemia. The skilled operator, however, will observe that the anterior chamber has become much more shallow and that thereby the blood from the formerly deeper chamber

has been forced upward. Thus, while the novice will suspect a rupture of the wound with a fresh hemorrhage, the experienced operator will see only a shallowing of the chamber and will understand that the blood is old blood from the operation.

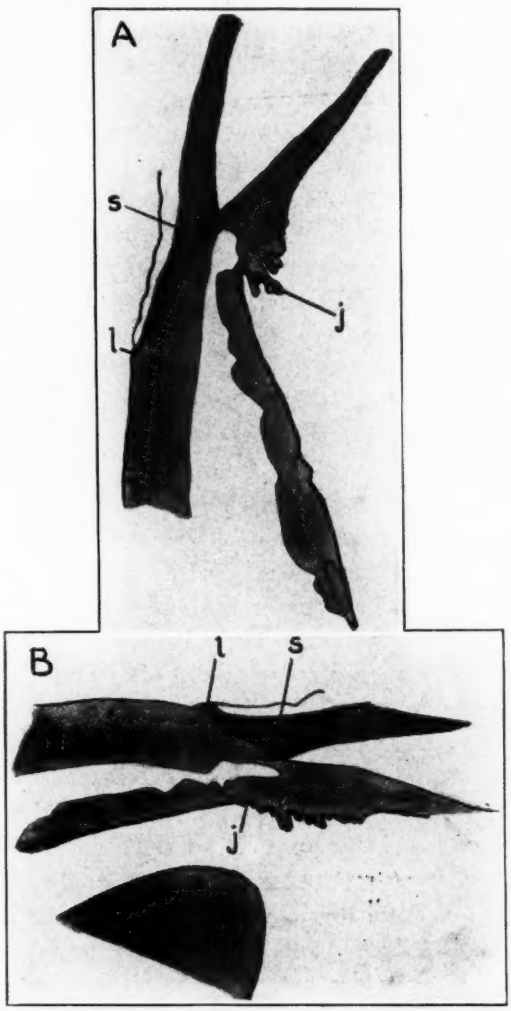

Fig. 5.—Angle of the anterior chamber: *A*, of an eye incised in the vertical meridian; *B*, of an eye incised in the horizontal meridian. In this figure *l* designates the limbus; *s*, the scleral spur, and *j*, the root of the iris.

Importance attaches to the concealed position of the angle of the chamber from the standpoint of foreign bodies, and here great care must be exercised. It happens sometimes that a foreign body lying on the iris in the depths of the anterior chamber disappears after the cornea is incised and the aqueous drawn off. If the foreign body is a particle

of iron it can be extracted by means of a magnet with comparative ease, but if it is not of iron peculiar difficulties present themselves. Then, too, it happens all too frequently that a sharp splinter buries itself in the root of the iris, as in the mass at *j* in figure 5 *A*.

In dealing with a foreign body lying on the iris it is highly advisable that the operator, in endeavoring to extract it, does not make the incision close to the foreign body but rather on the opposite side. If that precaution is taken, the force of the current of the outrushing aqueous will not wash the foreign body into the angle of the anterior chamber. Furthermore, if one follows this suggestion one can more easily grasp the foreign body with the forceps from the opposite side than if one inserts the forceps alongside or above the foreign body, which makes it impossible to get the instrument in back of the sclera. One must always picture to himself how the paracentesis is made and how difficult it is, by way of this incision, to enter the chamber angle of the same side. A glance at figure 9, which shows an incision with the keratome for glaucoma, will readily explain this.

The extension of the sclera over the choroid (limbus, *l*; scleral spur, *s*) plays an important part in determining the nature of the incision in every kind of operation on the anterior portion of the eye. In my atlas [7] I have taken special account of these conditions and have described in detail the location of the incisions with the knife and the keratome for glaucoma [7a] and the incision for extraction of cataract.[7b]

Of importance, and not sufficiently known as yet, is the fact that the sclera extends farther over the cornea above and below than at the sides. Since the time that Elliot's trephining came into general use these anatomic conditions have been much discussed, but of late many ophthalmic surgeons appear to have forgotten them.

In figure 5, *A* represents an eye that was incised vertically and *B*, an eye that was incised horizontally. Casual inspection reveals how much more the sclera extends over the cornea at the vertical meridian. In *A*, i. e., in the vertical meridian, the distance from the limbus (*l*) to the scleral spur is 1.7 mm., and in *B*, i. e., in the horizontal meridian, it is 1.1 mm.; thus the sclera extends 0.6 mm. farther over the cornea above than at the sides. This farther extension above is the reason why the cornea takes the shape of an oval lying on the longer section. Not infrequently, however, the cornea takes the shape of a vertical oval resting on its shorter section.

This is of especial importance for the Elliot trephining. At the time this operation was first recommended a demand was made, for this reason, trephine above, and if in certain cases one had to trephine

7. Fuchs, A.: Atlas of the Histopathology of the Eye, Vienna, Franz Deuticke, 1924, vol. 1 (*a*) p. 33; (*b*) p. 31; (*c*) plate 33 (fig. 1); (*d*) plate 30 (fig. 2).

in the horizontal meridian one was instructed to split up the cornea for a distance of at least 0.5 mm. Of course, the chief reason for trephining above is that the upper eyelid will cover the trephine opening and the iridectomy.

That these conditions are, unfortunately, to many operators a terra incognita is revealed by various anatomic specimens that I have received for examination, of which I will describe only one:

The eyeball of a woman aged 55 was trephined for acute glaucoma. The eyeball looked well after the operation, but after two weeks the pressure rose

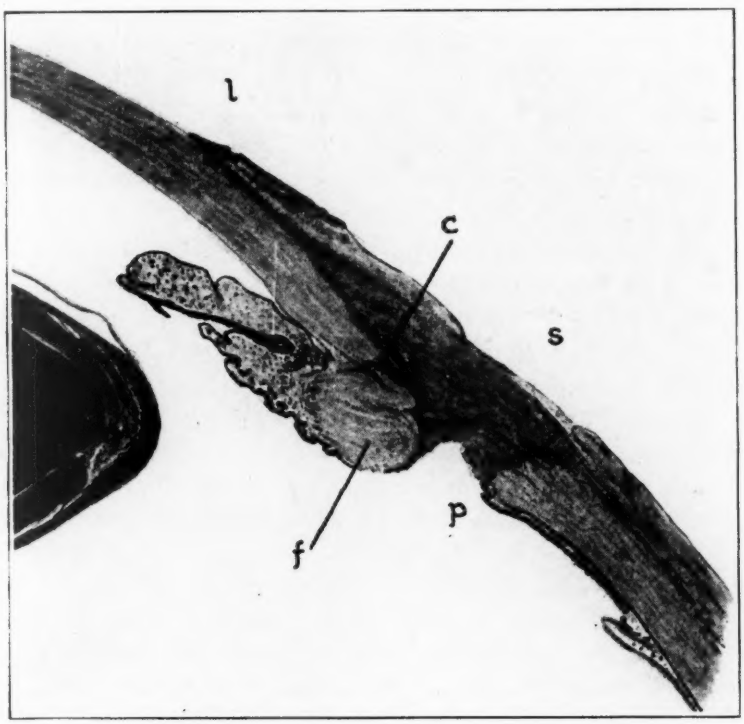

Fig. 6.—Wrong method of trephining. In this figure *s* indicates a large hole in the sclera; *l*, the limbus; *c*, the canal of Schlemm; *p*, the pigmented epithelium, and *f*, defect in pigment epithelium.

again; the vision was considerably lowered, and finally, six weeks after the operation, the eye had to be removed because of severe pain and high pressure (55 mm.). The operator had not suspected why the pressure had risen again.

The histologic examination showed, however, a large hole in the sclera, filled with dense scar tissue (*s*, fig. 6). The hole was 1.5 mm. in diameter and was located nearly 3 mm. behind the limbus (*l*), or much farther back than it should lie. On careful inspection, one found the canal of Schlemm (*c*) and the scleral spur. It was apparent, therefore, that the trephining was done at an entirely wrong place, namely, behind the canal of Schlemm and not in front of it,

and that, as a result, the ciliary body was pierced. On the posterior surface of *s* the pigmented epithelium was lacking; the flat portion of the ciliary body ended at *p* with the pigmented epithelium, and the pigmented epithelium began again farther in the front, above *f*. The wall of the eyeball together with the ciliary body was pierced, and the opening was filled with scar tissue, doubtless because there was vitreous in the wound and fistulization through the vitreous was impossible.

But that was not all. The trephined flap had not been removed but lay turned backward and covered with remnants of the ciliary body in the interior of the eye. The eye was destroyed by the increased pressure. At first after the operation the eye was still soft, because there was an opening in the eye and no doubt vitreous had flowed out; later, however, the incarcerated vitreous was replaced by connective tissue, and a solid scar formed. In spite of the severe injury of the ciliary body and the fact that the flap had fallen inside the eye, no marked inflammation developed—only a great increase of pressure.

The operator trephined too far back. The rule is to dissect the conjunctiva up to the margin of the cornea. One can ascertain how far the conjunctiva has been dissected free by bringing the conjunctival flap back upward into the normal position; then one can see by a fine line of blood how far one has advanced with the knife toward the limbus.

The operator must always carefully remove the flap that he excises. If it falls into the anterior chamber it irritates, as Meller has shown, the iris, and chronic iritis develops, whereby the eye is destroyed.

The operator must also know exactly the changes that occur in the anatomic conditions when the aqueous flows out.

What happens when in glaucoma the aqueous flows out of the incision? The lens-iris diaphragm is pushed forward, sometimes with considerable force, because in the posterior chamber and in the space occupied by the vitreous the pressure is higher than normal. At the same time the equator of the lens strikes against the wound, and the vitreous presses the lens forward. That is why in iridectomy for glaucoma I make the incision as slowly as possible and bring about the outflow of the aqueous as cautiously as I can. That is also why Elliot's operation gives such good results and why Salzmann's iridectomy ab externo is so satisfactory.

The sudden striking of the lens against the edge of the wound leads not infrequently to laceration of the capsule, which one does not as a rule notice clinically but which later leads to partial clouding of the lens and often to iridocyclitis and to enucleation. As a matter of fact, in histologic preparations of eyes operated on for glaucoma one finds all too often laceration of the lens capsule.

Such a rupture of the capsule of the lens will result very easily when the lens is swollen and when the capsule is under excessive tension, as it virtually always is if glaucoma is advanced. Hence in advanced glaucoma complications originating in the lens are unusually frequent, to

which Salzmann recently again called express attention. Therefore, I refuse to operate on an eye for glaucoma if the vision has been reduced to recognition of movements of a hand or to mere sensation of light (this applies only to chronic glaucoma). The advantages of such an operation are exceedingly questionable; the prospects of improvement are almost nil, and the danger of complications is very great. But if one has performed a globe-opening operation on an eye in which the stage of glaucoma absolutum has almost been reached, and inflammation and pain develop, nothing remains but to remove the eye; for sympathetic ophthalmia may arise if the eye is not removed. In my series of one hundred cases of sympathetic ophthalmia no fewer than eight occurred following operations for glaucoma.[8] It is therefore better not to operate on eyes with painful glaucoma absolutum but to treat them in a conservative manner with roentgen rays to keep them free from pain and to preserve them for their owners.

In figure *7 A* one sees an incision through an eye affected with chronic glaucoma, which was operated on a few days ago according to the Elliot method. One sees that the capsule of the lens (*c*) is ruptured, that the lamellae are lacerated and that the interspaces are filled with dark-colored blood (*b*). The capsule of the lens is drawn toward the wound. The canal at the corneoscleral junction is filled with a molelike fibrinous coagulum (*f*). The ciliary processes lie in the wound; apparently the insertion of the ciliary muscle at the scleral spur has been injured, for also a part of the muscle (*m*) lies in the canal. The trephine opening was placed too far back, for one sees in front of the opening a considerable portion of conjunctiva lying loose on the sclera.

In figure *7 B* there is shown the eye of a 64 year old man on whom an Elliot operation was performed five years previously. The canal is completely filled with solid connective tissue; the lens has been injured and is attached to this scar through the capsule. Thereby the lens has been drawn toward the wound, and the ciliary processes are wedged in between the lens and the sclera.

The second picture is apparently the consequence of an injury to the lens such as that shown in *A*.

In trephining one naturally makes the hole with the greatest care, but even then spontaneous laceration of the lens occasionally occurs. In ordinary iridectomy one must use similar caution when one adjusts the pillars of the iris with the spatula. Such injury of the capsule of the lens results nearly always in destruction of the eye. Either the lens becomes swollen, which leads to renewed increase of pressure, or lens substance occludes the fistulous opening, and the eye is destroyed by glaucoma. If no new increase of pressure appears, the now exposed

8. Fuchs, A.: Arch. de oftal. de Buenos Aires **7**:67, 1932.

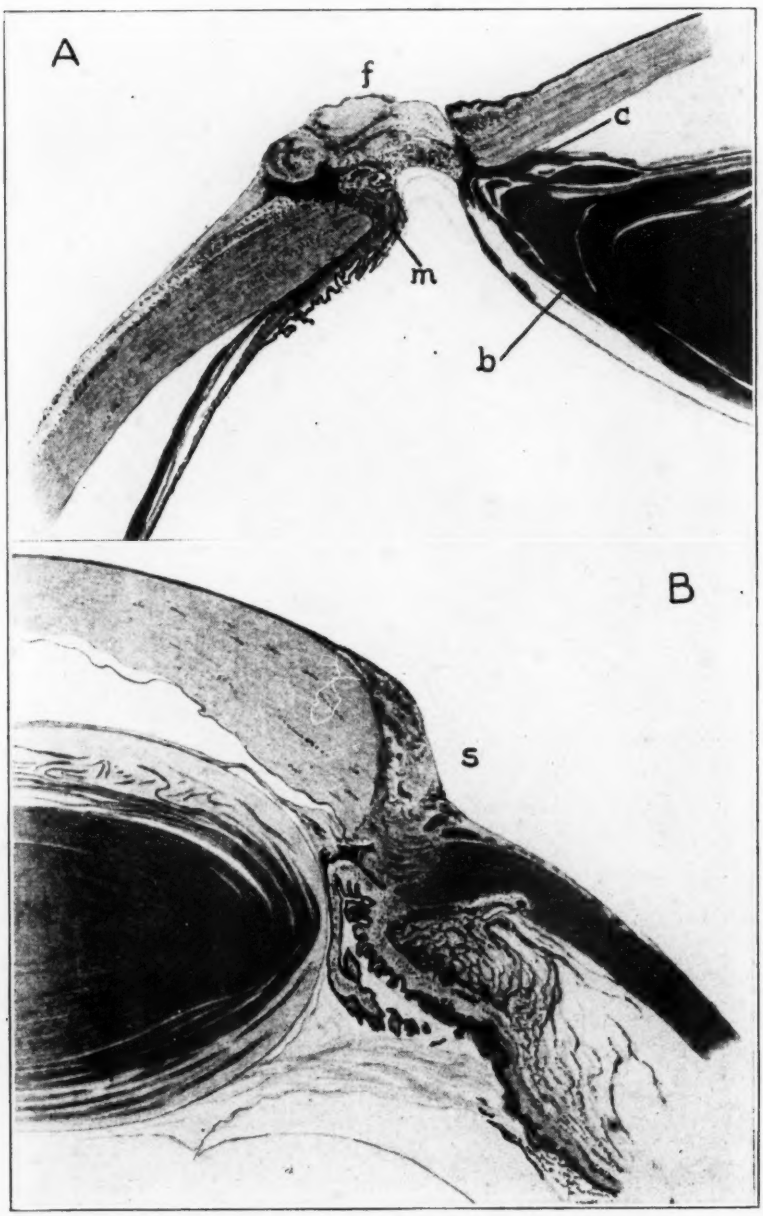

Fig. 7.—Injuries of the lens occurring during trephining: *A*, recent injury; *B*, old injury. In this figure *f* indicates fibrinous coagulum; *c*, the capsule of the lens; *b*, blood; *m*, muscle, and *s*, scar tissue.

lenticular substance acts often as a foreign body—irritating the tissues and causing traumatic serous iritis.

Another consequence of the advance of the lens-iris diaphragm is the prolapse of the ciliary processes into the trephine hole after excision of the iris. This is a very common occurrence. It is illustrated in figure 6. The posterior portion of the newly formed canal is occupied by the ciliary processes. In my atlas [7c] I have an illustration from a most excellent case, the outcome of which was a complete clinical success. When the chamber is abolished and the iris excised, the ciliary body, by reason of the vitreous, advances, and the ciliary processes come to occupy a position immediately back of the trephine opening. After excision of the vesicle of the iris in connection with the Elliot trephining one can often see on the side toward the sclera a small particle of yellow tissue lying in the trephine opening. This is a prolapsed ciliary process. One must not attempt to cut it out or even to touch it. That would cause grave damage, hemorrhage and later inflammation. It appears to me that in most cases the ciliary processes move back again and vacate the canal when the anterior chamber is again restored and when the eye, by reason of the fistulization, has become soft, provided the ciliary processes have not become adherent through fibrin because of irritation.

As every operator knows, one must instil atropine after trephining in order to combat iritis and to counteract posterior adhesions and this fixation. The cause thereof lies probably in the prolapsed ciliary processes, which become somewhat roughened and worn. That is to say, often a vicious circle is established.

The prolapse of the ciliary processes and their union with the surrounding tissues are of special importance for the question of possible later extraction of cataract. As is well known, one must plan the incision for the later extraction of cataract so that it does not pass through the site of the trephining. For example, if the site of the trephining was above, the incision should be below or to one side. The reason for this precaution is: If one were to make the incision through the site of the trephining one would doubtless sever the adherent ciliary processes and thereby induce not only grave intra-ocular hemorrhage but also grave damage of the eye later, together with inflammation, and probably still later, atrophy of the eye.

Hence in a glaucomatous eye in which there is incipient cataract it is better not to employ the Elliot operation but to perform iridectomy, since this not only makes possible but facilitates later extraction of the cataract. That is to say, the completed iridectomy makes further excision of the iris unnecessary and, if the incision is made correctly, one can operate almost without hemorrhage. A hemorrhage in a glaucomatous eye is always unpleasant, as it is reabsorbed with difficulty and often leads to blocking of the already impaired efferent paths.

For the extraction of cataract the advance of the iris-lens diaphragm after the outflow of the aqueous is important because it becomes thereby comparatively easy to "plunge" the lens; that is, to bring the margin of the nucleus of the lens forward into the wound.

THE IRIS

The following fact is of especial importance: If one has excised a piece of iris, there lies behind it, pushed back slightly by the ligament of Zinn, the vitreous with the anterior border layer. This is sometimes solid and sometimes not so solid. In any event, after the extraction of the lens, one should treat every coloboma with care. After an extracapsular removal of the lens, one can distinguish in the region of the coloboma two parts: the peripheral portion, where the vitreous presses against it, and the more central portion corresponding to the peripheral part of the iris. In the latter portion lies the equator of the capsule of the lens, which forms the ring-shaped Sömmering thickening of the periphery of the capsule after the operation for cataract.

This Sömmering thickening explains why in the ordinary operation for the removal of cataract the iris does not tremble to any extent although the lens is removed. If the lens has been removed within the capsule, this fact can be recognized later not only from the absolutely black pupil but also from the very tremulous condition of the iris. In the latter case the vitreous humor presses forward more than in the case in which the operation was extracapsular, and this is probably the reason why later the pupil so often rises upward and the root of the iris is pressed secondarily against the posterior wound of the cornea. It is certain that the tremulous condition of the iris and this instability of the anterior border layer are not without effect on the colloid equilibrium of the vitreous, and detachment of the retina following intracapsular extraction, an occurrence which is relatively frequent, is perhaps ascribable to this tremulous condition or lack of stability of the iris.

These details of the anatomy of the area of the peripheral coloboma are of special importance for the operator who performs peripheral iridectomy after the Hess method. He finds himself then in the region of Petit's canal, in front of the circumlenticular space. If he has produced a small defect in the periphery of the iris he should take care not to make an entrance at this point again with any instrument. If he does, it may happen that he will injure the anterior border layer, and then the vitreous will flow off, thereby enlarging greatly the small defect in the iris.

If he has attempted to excise a small portion from the periphery of the iris but is not certain whether or not he has succeeded, he should take care not to repeat the attempt at the same point; for it might happen

that through a small defect not observable through the limbus he will come in contact with the vitreous and will tear out with the iris forceps a portion of the anterior border layer, which will result in loss of vitreous. It is much better to perform a new peripheral iridectomy, more to the nasal or to the temporal side, since for the purposes of peripheral iridectomy it is not important whether the defect is straight above or more to one side, and cosmetically it is not significant since both points are covered by the upper lid. If he has made two defects, it does not matter particularly. Occasionally a second defect is made if the iris at any point cannot be reduced and the lack of rotundity of the pupil points to incarceration of the iris.

In any event, after making a peripheral button-hole iridectomy, it is advisable (in the manner of Professor Meller) to spread out on the finger whatever may have been excised, in order to discover whether really iris tissue or pigment from the excision is sticking to the teeth of the forceps. If iris is not found the excision should be repeated at a point near by, as stated.

Vitreous may flow through the peripheral defect in the iris likewise spontaneously. After removal of the lens and the making of the defect in the periphery of the iris the defect may suddenly become enlarged and vitreous exude through it.

As a rule, the operation with a round pupil is regarded as the better for extraction of cataract, since it is easier to control by the roundness of the pupil the reposition of the iris. Incarceration of the iris is certainly the cause of most complications, although every incarceration does not lead to complications. Cicatricial ectasia of the iris, chronic iritis, sympathetic ophthalmia, fistulization, increased pressure and migration of epithelium are all caused by it. Reposition of the iris is likewise much easier when the pupil is round. It is important for the reposition that the incision should not be made too near the periphery. The incision should come out above, just back of the limbus; then the wound does not bleed, and it is easy to strip the iris back. But if the iris is strongly incarcerated, an event which is due as a rule to the fact that the incision was made too far posteriorly, one can occasionally (the greatest caution is indicated) grasp the iris in the region of the sphincter with the iris forceps and draw it toward the middle of the pupil. Great care is needed in order not to tear away the iris from its root, and one must not, therefore, pull it too far from its insertion. It should be understood that one does not resort to this maneuver unless all other means have been tried in vain.

In extraction with a round pupil incarceration of the capsule is also probably much more rare than in total iridectomy, since with the stripping back of the iris the invisible capsule also is removed from the incision.

On completing the extraction one sometimes sees, on stripping back the conjunctival flap, some pigment under the conjunctiva. In one case of my series Tennent [9] was able to demonstrate the origin and cause of this. The scraps of pigment must be scrupulously removed by raising the conjunctival flap with the forceps and stroking the pigment away with the spatula. Sometimes such particles of pigment may be carried through the wall toward the iris and may give rise to fistulization and imperfect closure of the wall.

As stated, the depth of the chamber is determined, on the one hand, by the position of the lens, and, on the other, by the thickness of the root of the iris and by that of the iris itself.

The root of the iris is of varying thickness in different persons and even in different parts of the same eye. Sometimes it consists of

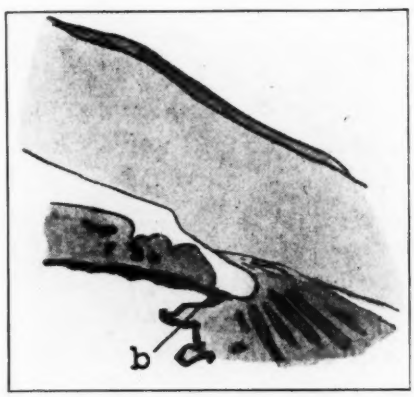

Fig. 8.—Slender root of the iris (*b*).

only one layer of pigmented epithelial cells (*b*, fig. 8); sometimes there is a thin stroma present (*j*, fig. 5 *A*), and at other times the root of the iris is thick (*j*, fig. 5 *B*), because the anterior border layer of the iris does not end with the root, as is usually the case, but extends to the ciliary body.

The varying thickness of the root of the iris is important for the clinician because it explains why in certain cases iridodialysis occurs so easily and is so extensive. Recently two cases have been reported by Mandicevski.[10] In one case slight iridodialysis was produced by the mere incidence of very strong sunlight reflected from a window, and in the other case the same effect was produced by very brilliant light from a slit lamp.

9. Tennent, J. N.: Lancet **2**:1174, 1927.

10. Mandicevski: Klin. Monatsbl. f. Augenh. **94**:668, 1935.

The thickness of the root of the iris is of importance also for the operator. He should know that the root of the iris may be torn much more easily and is much more yielding than the remaining tissues of the iris. If, when a Graefe knife is passed through the anterior chamber, it catches on a fiber of the iris, it may tear off the latter if the root of the iris happens to be very tender. This is still more likely to happen in iridectomy for glaucoma. Some, in an endeavor to excise the iris as near the periphery as possible, draw the iris so far forward that it is not excised but torn off. This happens especially when the iris is excised in three stages. This is done in order to excise the iris as completely as possible and as near as possible to its insertion. The iris is drawn forward tent fashion, and first one lip is cut through, then the uppermost part is severed, and finally, after the iris has been drawn toward the other margin of the wound, the other lip is cut off. In doing this the operator exerts pressure on the wound with the shears and traction on the iris with the forceps. While this method, which is employed particularly by Meller, is very good, one must take care, in making the second incision, not to draw the iris too violently toward the margin of the second wound, because thereby the iris is often torn from its insertion.

It may be alleged that it is of no particular consequence whether the periphery of the iris is excised or whether the iris is torn loose at its root. It may even be contended that iridodialysis is much better than peripheral excision. I deny both allegations, for just the opposite is true. Very often the tearing loose of the iris at the root causes the angle of the chamber to be blocked, as I can demonstrate, but first I wish to report a case in which the tearing loose of the iris was attended by no damage but brought good results.

Figure 9*A* shows a case in which in connection with a keratome iridectomy with a shelving incisional scar (*s*) the iris was torn loose. Between the ciliary muscle and the beginning of the pigmented epithelium the tissues lie bare. In fact, at *t* a small tear in the bundle of muscular fibers appears to have occurred. The iris has been torn loose, and by the traction on the iris the muscle also has been lacerated. The bundles of the pectinate ligament are loosened, and the filtration corner appears to be clear. This seems to be an ideal result, and in this particular case it was an ideal result. Unfortunately, however, this outcome is the exception; much more frequent is the condition described in the following paragraph.

In figure 9*B* the scar resulting from the Graefe iridectomy (*s*) is some distance from the angle of the chamber, although the incision had been made some distance back of the limbus. The incision passes obliquely through the cornea and sclera; the marked extension of the upper

limbus over the anterior chamber was not taken against the sclera, and the pigmented epithelium is continuous from the ciliary processes over the pectinate ligament (*p*), extends farther on the posterior side of the cornea, and passes over the posterior margin of the iridectomy scar.

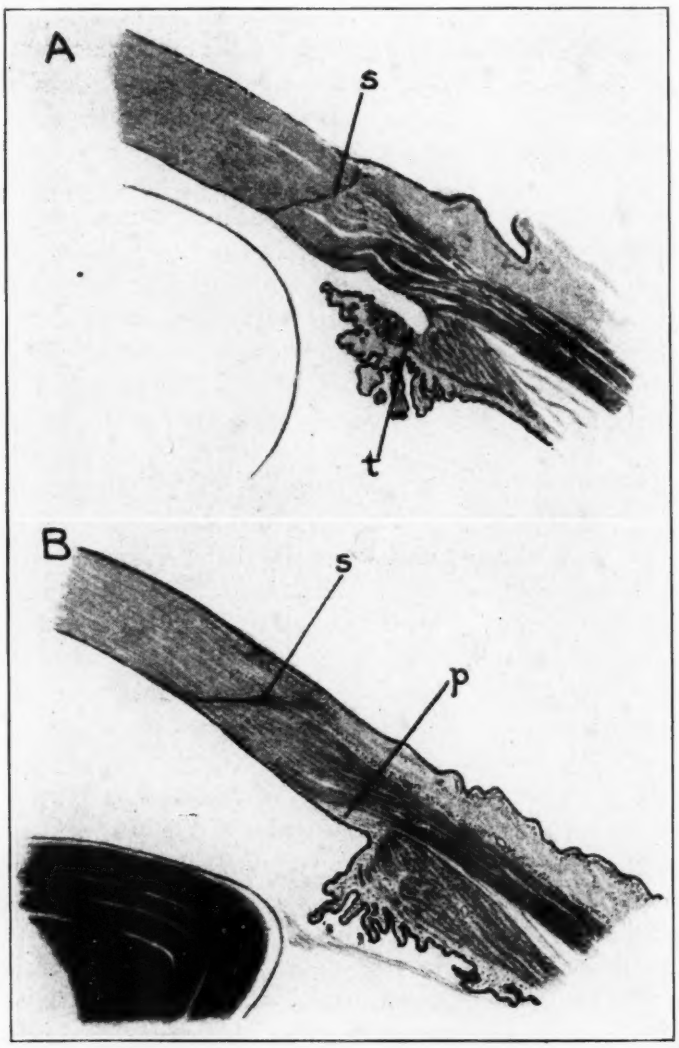

Fig. 9.—*A*, iridodialysis with an open angle of the chamber; *B*, iridodialysis with a closed angle of the chamber. In this figure *s* indicates the scar; *t*, a small tear, and *p*, the pectinate ligament.

The pigmentary layer lying on the trabeculae of the pectinate ligament appears to consist not of epithelial cells but of highly pigmented endothelial cells. In any event, the filtration is greatly hindered by this

layer of cells; the canal of Schlemm has disappeared almost entirely, and the spaces of Fontana have become greatly narrowed.

Very frequently the wound in the ciliary body grows fast to the pectinate ligament. This happens because after the incision the anterior chamber is abolished; the ciliary body is therefore pushed forward, and the wound of the ciliary body is brought in contact with the pectinate ligament. This often gives rise to adhesions and renewed increases of pressure.

THE SCLERA

Likewise in the sclera there are many details of importance to the operator. Calcification of the sclerotic coat in aged persons is an important and by no means rare phenomenon. I found in my records three cases—all in women—in which calcification caused me very great trouble during operation. In two cases operation for cataract was involved, and in one case iridectomy for glaucoma. One experiences great difficulty at the first incision with the Graefe knife, and one finds it difficult to make an entrance to the anterior chamber, whereas in the absence of calcification one can pass the knife through the anterior chamber without any special effort. In these cases it seemed as if the knife were in a vise. I could scarcely move the point up and down, and likewise counter puncture required the greatest effort. In completing the operation the knife could be readily advanced on the nasal side, whereas on the temporal side it stuck. The position of the knife at the close of the operation was entirely oblique, and at the last several sawlike movements were necessary to finish the section.

Histologically there are two types of calcification: First, there is diffuse calcification, particularly of the external layers. One sees numerous small particles of lime, which in sections treated by the hemalaum-eosin method stain a deep dark blue. In my specimens the calcification almost never affects the whole thickness of the sclera and never very large portions of the circumference but often appears at various places. Figure 10 *A* shows diffuse particles of lime (*c*) posteriorly in the external scleral layers on the temporal side in a case of glaucoma secondary to detachment of the retina.

The second type of calcification is the formation of sharply circumscribed clumps of lime [11] such as may be seen in fig. 10 *B*. One sees in an area 0.25 by 0.5 mm. a sharply circumscribed dark blue deposit, which has a lamellated structure. It is located on the inner side of the sclera a short distance in front of the ora serrata. The eye is that of a man aged 22. The eye had shown signs of shriveling since birth and

11. Compare also B. Klien-Moncreiff (Isolated Foci of Calcification in Sclera: Anatomic and Clinical Aspects, Arch. Ophth. **7**:757 [May] 1932) and M. Lewi (Ztschr. f. Augenh. **79**:180, 1932).

had been a center of pain for four years. It is an atrophic globe, which in the posterior region shows bone formation. The deposit of lime is an accidental occurrence and appears to have no connection with the other degenerative processes evidenced in the atrophic eyeball.

Calcification of the sclera is a very unpleasant surprise in connection with an operation and can seldom be foreseen. A very sharp

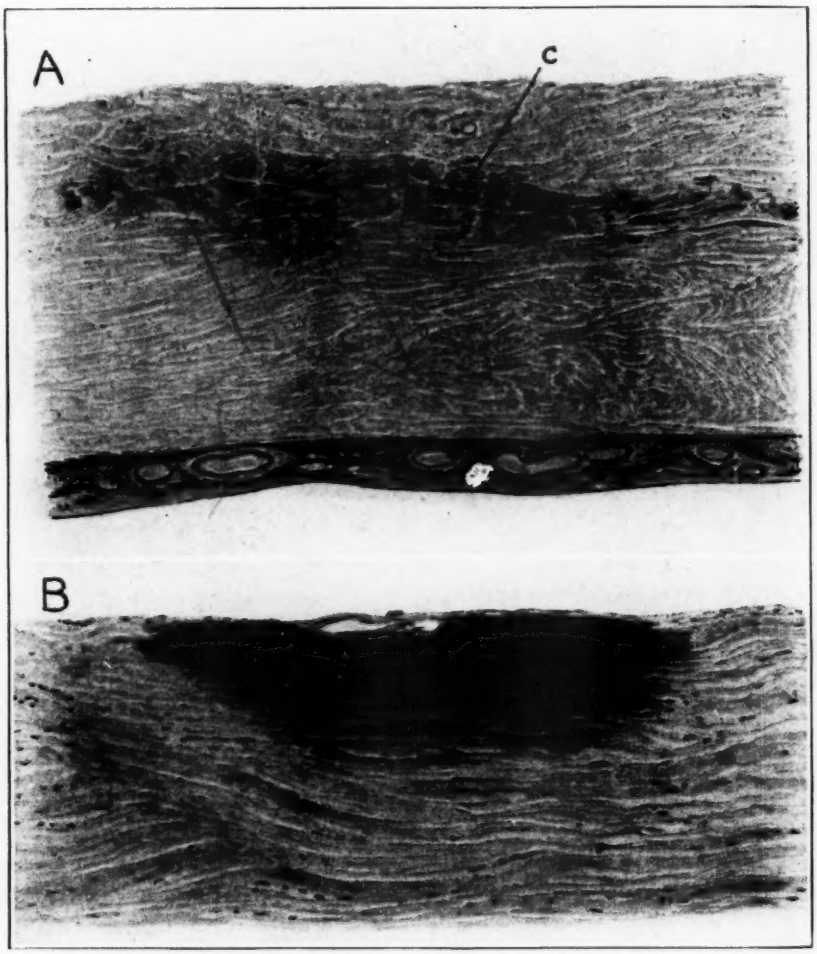

Fig. 10.—*A*, diffuse calcification (*c* indicates particles of lime); *B*, clump of lime.

Elschnig forceps, with which one can hold the sclera firmly, is a very useful instrument under such conditions. But as a rule I do not use the Elschnig forceps in operations for cataract, as it appears to me that the scleral wound caused by the long sharp needle-like blades contributes to the irritation of the eyeball after the operation. But when

on inserting the Graefe knife, which has been previously tested for its sharpness, I note an unusual resistance, I draw back the knife, if the anterior chamber has not yet been opened, and take up the Elschnig forceps.

If the anterior chamber has been opened, one cannot use the Elschnig forceps, for the reason that one cannot get a good hold on the globe and the sclera unless one can apply the blades of the forceps very heavily to the sclera, which is impossible once the anterior chamber is opened. In this case one must force the action of the knife as best one can. In making the incision it is usually better to hold the Graefe knife more centripetally than tangentially; that is to say, the point of the knife should be directed toward the center of the eye. It may happen that if the resistance is suddenly removed the knife will slip into the eye farther than one originally intended. In removing a cataract very likely this would not be so significant, but in iridectomy for glaucoma it would be a catastrophe, and one could possibly avoid such an occurrence by choosing some other method of operation.

Counterpuncture in the presence of a calcified sclera will be effected more readily perhaps if one endeavors with one or more jerks to push the knife through the cornea. The completion of the operation will doubtless usually be easier if one resorts to several sawlike motions, although one may have the feeling that the knife is being "choked" by the firmness of the tissues.

Also of especial importance for the operator is the varying thickness of the sclera. This has been particularly true in recent years owing to increased interest in the posterior portion of the sclera by reason of the operations for detachment of the retina. In myopia the sclera is much thinner than usual, and at the equator it may be so thin that it appears quite blue, because the uvea shimmers through. In myopia, indeed, the sclera may actually present holelike defects.[12] If one uses the diathermy method and needle electrodes in operating for detachment one must in the presence of an abnormally thin sclera employ much shorter needles than would be required if the sclera were normal, as it may happen that one will make holes not only in the sclera and the choroid but also in the retina, leading naturally to a recurrence of the retinal detachment.

Even in normal eyes the thickness of the sclera varies with age and sex. According to Salzmann, the sclera is thinner in females than in males. It is thickest at the posterior pole of the eye (1 mm. or more), becomes thinner at the equator (0.4 to 0.6 mm.) and is thinnest (0.3 mm.) immediately back of the insertions of the recti. These places are

12. Plocher, R.: Klin. Monatsbl. f. Augenh. **62**:94, 1919. Hanssen: ibid. **63**:325, 1919.

covered, to be sure, by the muscle tendons. Before insertion of the recti the sclera is about 0.6 mm. thick, and this thickness continues up to the margin of the cornea.

The thickness of the sclera plays a part also in operations for strabismus. In muscle advancement, the sutures that draw the muscle forward and hold it in the vicinity of the limbus must pass not only through the conjunctiva but also through the superficial layers of the sclera. This is possible, to be sure, only if one has good needles especially adapted to the purpose.[13] It has happened (though I have never seen it myself) that an operator has inserted the needle too deeply in the sclera and thereby brought about an infection of the interior of the eye. It is the rule in the advancement maneuver to make the suture not far from the limbus so that if the needle should be inserted too deeply the penetration would occur in the region of the anterior chamber and not in the vicinity of the ciliary body. An infection of the anterior chamber would be much less dangerous than an infection of the ciliary body, which would be sure to lead to endophthalmitis and destruction of the eye.

Importance attaches also to the fact that behind the insertion of the recti the sclera is very thin. Many years ago I assisted a woman physician to perform her first tenotomy. She had grasped the muscle with a strabismus hook, and with curved scissors pressed flatly against the sclera she had severed the insertion of the muscle. Suddenly I saw a black bead like a blister rise up from the incisional wound—the vitreous. We ended the operation at once and closed the conjunctival wound. I had great fears for the eye, but nothing happened. The results of the tenotomy were good, and no inflammation developed.

It was evident that through the removal of the tendon with the strabismus hook the thin sclera was raised up tent fashion and was cut off with the scissors. This will be readily understood when one recalls that the sclera behind the insertion of the tendon is only 0.3 mm. thick.

Another place in the sclera is important for the operator, namely, the region of the optic disk. In a myopic or a glaucomatous eye, and particularly in one in which the two diseases coincide, a circumscribed protrusion of the sclera in the vicinity of the optic disk may occur. This condition may be recognized also clinically. It was described by von Graefe, and in a previous article I have illustrations from a number of cases observed clinically and histologically.[14] At the same time, not only the lamina cribrosa but also the adjacent portion of the sclera, which forms the roof of the vaginal fornix of the sheath of the optic nerve, are

13. The needles must be very flat and pointed, but the sides must not have a cutting edge.

14. Fuchs, A.: Am. J. Ophth. **7**:257, 1924.

forced backward. Figure 11 shows such conditions in hydrophthalmos. The excavation affects an area three times as large as the optic disk. Especially to the right one sees how the roof of the fornix (*r*) and the adjacent parts of the sclera (*s*), on which the choroid and the retina have partially disappeared, are involved in the excavation.

If, in applying enucleation to such an eye, the scissors are pressed hard against the posterior pole and are closed when one thinks one has the optic nerve between the blades, it may happen that the protruding portion is cut off. Thereupon the contents of the eye run out, and one has only an empty sac in the forceps, which is difficult to excise. In

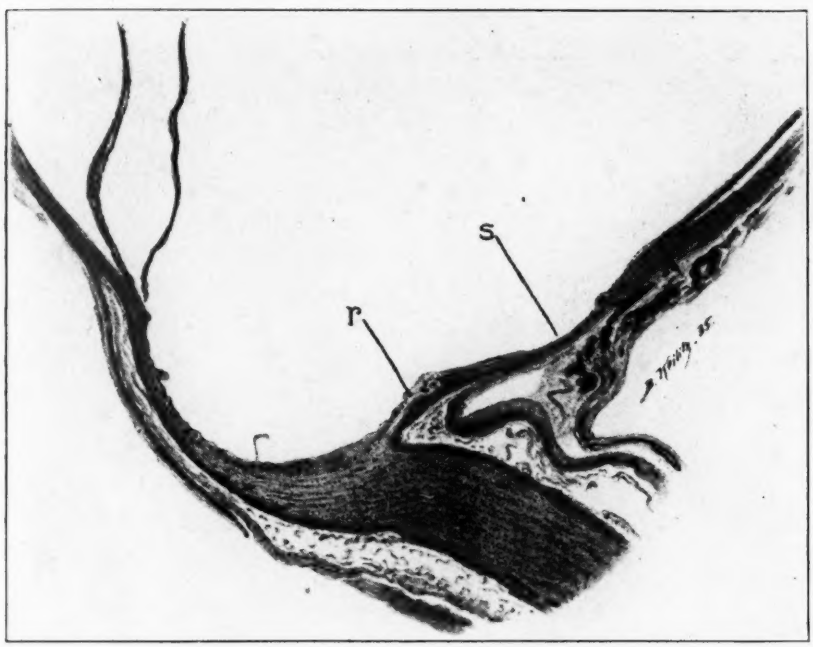

Fig. 11.—Posterior portion of the eye in hydrophthalmos. Here *r* indicates the roof of the fornix and *s* the sclera.

addition, a portion of the eye remains in the orbit, and the histologic preparation is ruined. I once saw such a complication when an operator with great labor had had the head of a fibula taken from his patient (prepared by a surgeon) with the idea of implanting it in the orbit in place of the eyeball. When he then performed the enucleation he met with the aforementioned accident. He was of course compelled to probe deeply to discover the remainder of the eye and to extirpate it in order to implant the head of the fibula.

In a similar manner the contents of the eye may run out if the excavation caused by secondary or absolute glaucoma extends far backward

and the lamina cribrosa is recessed to an unusual degree (fig. 12). In cutting off the optic nerve, the operation on the nerve is performed correctly, but the lamina cribrosa that was bent backward is lopped off, and the contents of the eye escape.

Something similar happened to me once in a case that had other interesting features:

A man aged 70, from America, had suffered an injury to his right eye as a child; at that time an internal hemorrhage was manifest. He recovered the sight of the eye for a time, but later it became entirely blind. When he consulted me he had had pains for three weeeks.

The right eye showed a ciliary injection. The cornea was lusterless, the pupil narrow and the anterior chamber deep. A membrane extended over the iris, and

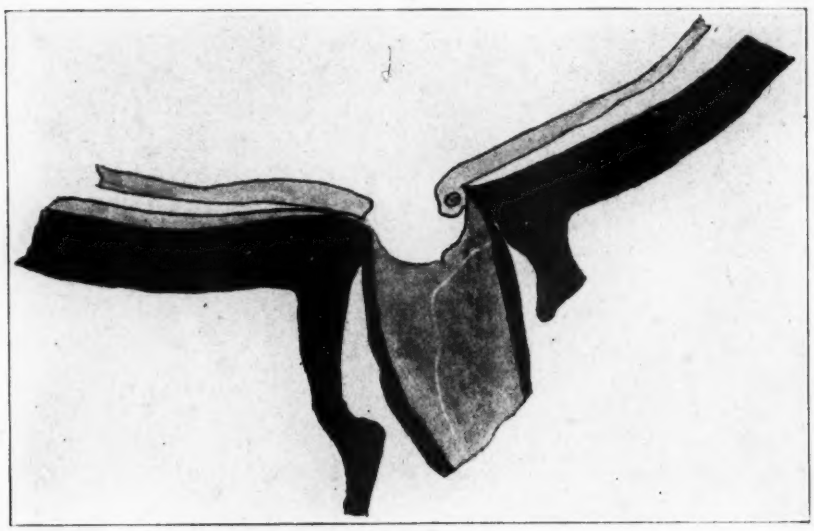

Fig. 12.—Deep glaucomatous excavation.

there were posterior synechiae. Diascleral transillumination revealed definite obscuration of the posterior portion of the sclera.

While he was still in America there was a suspicion that a tumor was present behind this secondary glaucoma, and the transillumination led me also to believe that the shadow in the posterior part of the eye was due to a pigmented tumor that had become necrotic and hence had produced iritis and the membrane.

During the operation I excised the optic nerve back of the eyeball in the way I was in the habit of doing. But at the very same moment the eyeball collapsed, and a dark brown fluid deluged the operative field. Still under the impression that I was dealing with a melanosarcoma that had become liquefied as a result of necrosis, I excised another portion of the optic nerve, cleansed the wound cavity meticulously and closed the conjunctiva.

The histologic examination revealed, however, no necrotic tumor; the shadow had been caused by the remains of an old subretinal effusion of blood. In the old blood a large quantity of blood pigment had developed; for only that could

have produced such a sharply circumscribed shadow. The diagnosis was thus secondary glaucoma resulting from detachment of the retina, together with an old hematoma behind the detached retina.

Here I made for the first time the observation that in excising the optic nerve a deep glaucomatous excavation may be excised, and that thereby the eyeball may lose its contents. Hence one should make it a rule not only in treating a tumor of the interior of the eye but also in dealing with myopia and glaucoma to excise the optic nerve far back. This is especially important if the condition is glioma of the retina, because glioma in contradistinction to sarcoma very frequently invades the optic nerve and advances along this lead. For the patient a great deal depends on whether or not the optic nerve is entirely free from glioma at the point of the incision. A white, dry, crumbling transverse section of the optic nerve evidences the presence of glioma. Once the optic nerve has been excised the task of locating its orbital portion again is unpleasant and laborious since following excision it retracts immediately into the depths of the orbit. Moreover, if evidence of glioma is found in the transverse incision it is certain that contaminating particles have been inoculated in the orbital tissues. Hence, if one finds evidence of glioma at the point of the transverse incision one must remove a large portion of the orbital tissue, resect the optic nerve as far back as possible and plant radium needles in the orbit or apply postoperative roentgen radiation. In any event, it is best in such cases to excise the optic nerve very far back, and if proper care is taken it can be severed from 1 to 1.5 cm. back of the eyeball.

A place of particular interest for the operator on the sclera is the line of the ora serrata. Formerly, when operations for detachment of the retina were still rare, the localization of points on the retina was not so well worked out, nor was it necessary. For cyclodialysis the operator sought a place about in line with the ora serrata and endeavored, above all, to operate in the region of the peripheral portion of the ciliary body, choosing thus a place from 6 to 7 mm. behind the limbus as the site for the incision. For an operation for detachment of the retina, particularly for the original Gonin operation, the precise position of the ora serrata was more important than now. In recent years numerous data in regard to its localization have been published. Vogt gave the distance behind the limbus as from 8 to 9 mm. Rubbrecht,[15] on the other hand, gave "about 8 mm." as the extreme limit of ophthalmoscopic visibility. The visibility with the ophthalmoscope depends to a great extent on whether one examines the fundus with the inverted or with the upright image. With the former, one can examine the fundus considerably farther anteriorly (about the diameter of the optic disk,

15. Rubbrecht: Bull. et mém. Soc. franç. d'opht. **43**:365, 1930.

or 1.5 mm., farther) since the prismatic effect of the intervening lens aids the examination. But even with the inverted image one can by no means see the ora serrata. At the most one sees a dark discoloration or a mottled appearance, which is doubtless due to Blessig-Ivanoff cystoid degeneration of the retina in the region of the ora serrata.

Amsler [16] gave 8 mm. or occasionally from 9 to 10 mm. as the limit of the visible periphery. Gonin [17] assigned 7 mm. as the distance to the ora serrata on the nasal side and 8 mm. on the temporal side, and for myopia he assigned 8 mm. on the nasal side and 9 mm. on the temporal side. Likewise Gonin regarded the ora serrata and the limit of visibility as identical.

Precise researches were made by Wagner.[18] He reported a highly variable magnitude for the distance from the ora serrata to the limbus, which nasally is as much as 2 mm. less than temporally. For myopia he assigned still higher values than Gonin.

In order to determine the precise localization of the ora serrata diascleral transillumination with a strong lamp is sometimes distinctly advantageous. For many years I have used for diascleral transillumination the Hess-Hammer lamp, which is provided with a light-tight cone. It has the advantage that with the aid of a rheostat the amount of light thrown into the eye may be regulated, and with a strong source of light it transilluminates well very dark eyes and enables one to discover details that are not visible with either the Sachs or the Lange lamp. Very often it is possible in this manner to bring the ora serrata into view, because frequently the pigmented epithelium of the ciliary body is much darker than that of the pigmented epithelium of the retina. Thus it is often possible to make an exact measurement.

IRIS BOMBÉ

It is important for the operator to know the anatomy of total posterior synechia and of iris bombé. The former is a matter of superficial adhesion between the posterior surface of the iris and the anterior surface of the lens. In this condition the periphery of the iris may be (1) in a normal position (left side of fig. 13), (2) bowed forward or (3) drawn backward through adhesion to the ciliary processes (right side of fig. 13). A careful inspection of this region, the angle of the anterior chamber, with lateral illumination (the slit lamp often does not give a correct view) will frequently make the condition clear to one if one has the correct conception of the anatomy.

16. Amsler: Klin. Monatsbl. f. Augenh. **86**:1, 1931.
17. Gonin: Ann. d'ocul. **168**:1, 1931.
18. Wagner: Arch. f. Ophth. **127**:103, 1931.

If one must perform iridectomy because of increased pressure one will be successful in cases 1 and 2 if one creates a space between the anterior and posterior chambers through excision of the iris. But if the periphery is adherent to the ciliary processes iridectomy at this point will avail nothing, as such a connection cannot be restored.

In order to perform iridectomy for optical reasons one must select another point in the iris, and not the spot where there is a total posterior synechia, for at such a site the iris is firmly adherent to the lens, and, while one can excise stroma here, the pigmented epithelium remains and one does not get a transparent coloboma, although it looks black because of the deposit of pigment.

Total posterior synechia occurs mainly in association with grave inflammation of the ciliary body. Whereas ordinarily the exudate from

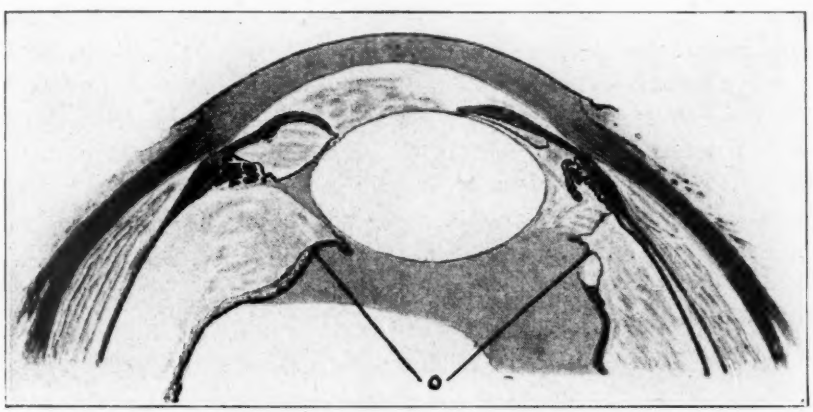

Fig. 13—Pseudo iris bombé. The detached ora serrata is shown at *o*.

the iris is carried forward and at the most fastens the margin of the pupil to the lens, producing posterior synechiae of a simple kind, which may easily be broken up, in grave involvement of the ciliary body the toxins from the posterior region act on the iris and posterior excretion of exudate results, a condition much like that often observed in grave septic endophthalmitis. Exudate emerges also from the ciliary processes into the space between the lens and the posterior surface of the iris, and thus these two elements become adherent over a wide area.

Hence, from this point of view, it is better for the operator not to seek out a place where there is a total posterior synechia, although at just such a point the deeper anterior chamber possibly points to an easier operation; for by such an intervention, accompanied by traction on the iris, an inflammatory process in the ciliary body that has just quieted down may be caused to flare up again.

For operation on iris bombé the following details are important:

1. According to E. Fuchs, transfixion gives good results in connection with increased pressure only when the iris bombé is not of long standing (less than two weeks); for if it has existed longer than this the root of the iris, which is in contact with the cornea, will, as a result of the inflammatory process, have became adherent to the cornea, and the fluid can doubtless pass from the posterior into the anterior chamber but can no longer flow outward through the canal of Schlemm.

2. Not in every case of iris bombé is the whole iris bowed forward. There are cases in which first total posterior synechia exists; later the fluid of the posterior chamber penetrates the iris through a defect in the pigmented epithelium, and the stroma of the iris buckles and bows forward while the pigmented epithelium remains adherent to the lens. In the iris pictured in figure 13 there was originally an extensive posterior synechia, while the pigmented epithelium had become adherent to the ciliary processes. To the right the adhesion of the iris to the lens was not so extensive. On both sides the fluid had bowed the iris forward for a considerable distance. Posteriorly not only the retina but also the unpigmented epithelium of the ciliary body were detached, a condition which occurs not infrequently in detachment of the retina of long standing. This was pointed to by the condition of the ora serrata (*o*), which was likewise detached.

In such cases an examination by means of transscleral illumination will be enlightening.

3. When iris bombé is associated with hypotension operation is contraindicated, since atrophy of the eyeball is already in the offing and would be accelerated by operative intervention. Hypotension in a patient with severe iridocyclitis is only a symptom of severe infiltration and a complete breakdown of the function of the ciliary body.

4. In connection with sympathetic iridocyclitis one encounters not infrequently clinical evidence of iris bombé, but the histologic examination reveals that the iris protrudes tumorlike, although the fluid of the posterior chamber has not bowed it forward (fig. 14). In spite of the increased pressure it is better to refrain from operating, since the penetration of the inflammatory tissues by a knife might cause severe exacerbation of the condition.

THE ZONULA

The operator has not so much to do with the zonula—not even now that the intracapsular operation for cataract has become so much in vogue.[19] In this operation not the zonula itself but most commonly its

19. The good reports of the adherents of the intracapsular method are surprising when one sees the bad late results of operations by this method, which immediately following the operations appeared so promising.

insertion at the capsule is torn off, owing to the lateral shifting of the lens. The variation in the fixation of the lens to the zonula and particularly the slight stability in association with the hypermature cataract are doubtless due to the fact that the zonula is connected with the capsule by a delicate membrane of its own which varies in stability. Sometimes in anatomic preparations the fixation process causes the zonula to become loosened from the capsule.

But it is important for the operator to know that the most posterior zonular fibers are inserted at the ora serrata. In connection with the shrinking of a traumatic cataract one sees not infrequently in anatomic preparations the ora serrata drawn toward the lens. This may cause a

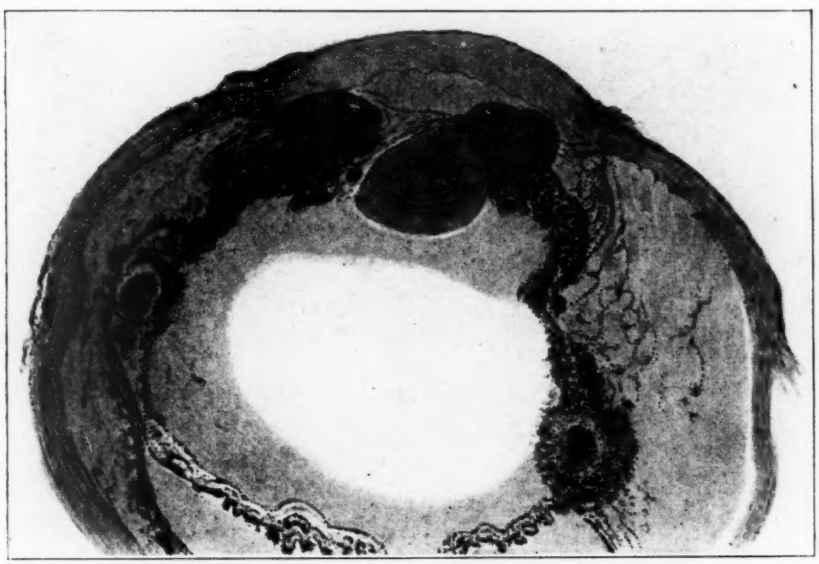

Fig. 14.—Sympathetic ophthalmia.

detachment. If at the same time there is increased pressure the retina, without becoming detached, is drawn forward over the ciliary body, which Leber termed "supertraction of the retina over the ciliary body." This is most likely to occur if not only a shrinking cataract is present but an ectasia of the anterior portion of the globe in the form of a staphyloma intercalare or a staphyloma of the cornea.

Through traction on the strands developing in the fibers of the zonula, tears in the anterior portions of the retina are produced. Figure 15 shows such a tear. The preparation was obtained from a child aged 18 months who was operated on when 3 weeks old for congenital cataract and had to be operated on again when 8 months old. The pupil was drawn toward the temporal side; the anterior chamber was abolished, and the eye was hard and greatly enlarged.

The iris is pressed against the cornea, and the lens has become a thin connective tissue from which very delicate strands extend toward the ora serrata. The most anterior portion (*p*) of the retina is torn loose from the main body and having been pushed forward is lying on the ciliary epithelium (*c*). The posterior margin of the tear (*t*) is partly atrophic, for it shows no series of nuclei. It is apparently somewhat detached from the base; less, however, than the illustration indicates, for the open split (*s*) on the right side has resulted from shrinking and is artificial. At *o* lies the ora serrata, for in front of it begins the single layer of cylindric epithelium on the flat portion of the ciliary body.

Also in iritis, membranes and strands are frequently formed along the anterior border layer of the vitreous and along the zonular fibers.

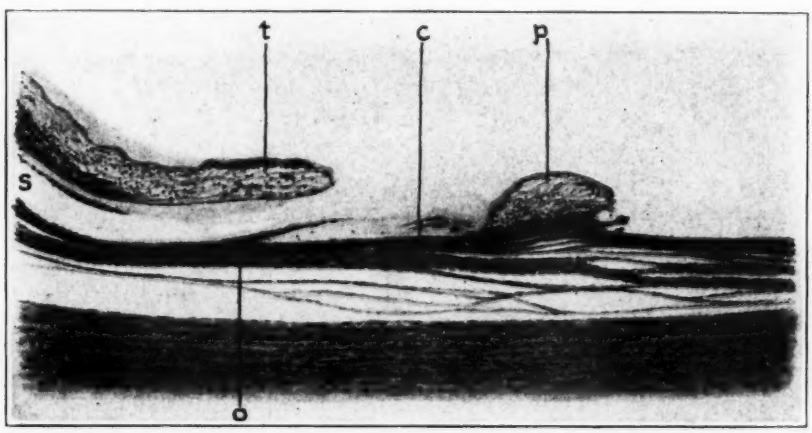

Fig. 15.—A tear in the ora serrata. In this figure *t* designates the tear; *c*, the ciliary epithelium; *p*, the most anterior portion of the retina, torn loose, and *o*, the ora serrata.

In operation on the lens in the presence of chronic iritis one must take care to prevent undue traction on the lens. If one is dealing with a complicated cataract one should avoid an intracapsular removal. If it is a question of a membrane at the site of the lens, a secondary cataract, it should be excised or lacerated without exerting traction on the zonula. Undue traction on the ciliary processes may cause hemorrhage or a flareup of a previously existing infiltration, while traction on the ora serrata may produce rents and consequent detachment of the retina. The procedure of grasping such a pupillary membrane with the forceps and drawing it out to excise it is exceedingly dangerous in an eye with iritis of long standing.

In discission of such a membrane one should endeavor to follow the instructions contained in the textbook of Meller. One should insert the

two discission needles in the middle of the membrane, and from these points one may cut the membrane apart on both sides, the needles being kept apart with a lever-like movement.

THE VITREOUS SPACE

If, in closing, I take up the details of the space occupied by the vitreous, I must mention above all the caution that the operator should exercise in passing a loop into the eye. The experienced operator will very seldom use a loop, while the beginner will often encounter difficulties. If one operates by the extracapsular method one will find that lenses with a small nucelus often cause great difficulty and that very rarely a large nucleus is the cause for resorting to the loop.

The small nucleus is harder to turn up; it cannot be made to present so easily, and, particularly if one operates on an eye with a round pupil, it often becomes hidden behind the iris. If one suspects that the abnormally small size of the nucleus is the reason why that element does not present in the wound, one can easily deliver the nucleus by pushing it down with the spatula and exerting pressure somewhat upward, toward the center of the cornea, at the same time bearing down on the scleral lip. In such cases, to be sure, total iridectomy is advisable.

Occasionally, by exercising great care one can remove a small nucleus with a loop. If this is attempted, one must not pass the loop far into the eye or around through the circumlental space or around the equator of the lens but must take out the nucleus in front of the posterior capsule. The correct technic will be evidenced by the fact that after withdrawal of the instrument no vitreous follows the loop.

In my atlas [7d] I have an illustration from a case in which during extraction with a loop the ciliary body was injured because the operator passed the loop too far into the eye. Examination of this illustration will convince many an operator of the need of caution. Injury of the ciliary body is nearly always accompanied by severe hemorrhage and consequent atrophy of the eyeball.

Special care must be taken in the insertion of instruments if the vitreous body is fluid and oozes out after the incision is made. This will be observed at once, since the anterior chamber is not abolished but becomes deep and since in the conjunctival sac fresh fluid continues to collect. Such fluidity is particularly frequent with luxation of the lens; it occurs occasionally with chronic iridocyclitis and is almost constantly present with detachment of the retina of long standing. Operation on such an eye is much feared, because the eyeball is nearly emptied of its contents, after the manner of an inverted tobacco pouch. Deep wrinkles and furrows develop, and one is very lucky if the eye recovers from the operation and fills again satisfactorily without shrinkage occur-

ring following the intervention because the eye can no longer excrete sufficient fluid to restore the normal tension.

If, during an operation, the eye becomes very soft, one must give careful attention to another detail. The tonus of the eye muscles draws the eyeball backward while the contents of the orbit, the fat and the optic nerve, furnish resistance. This play of forces may give rise to a marginal ridge about the optic disk, which is very important and which corresponds to what one finds in anatomic preparations of atrophic eyes

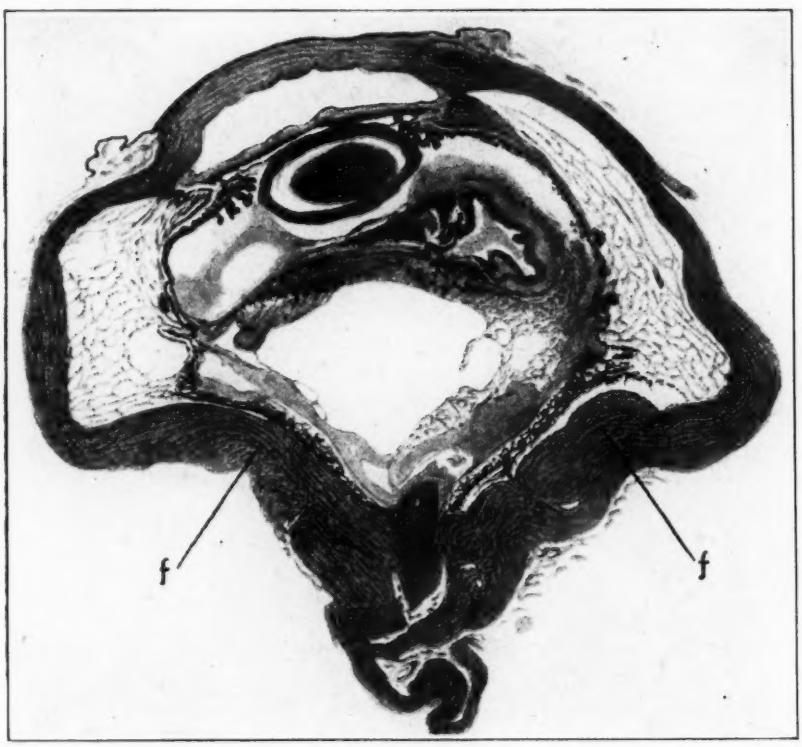

Fig. 16.—An atrophic eye with a fold at *f*.

(fig. 16). In the microscopic slide one sees a fold (*f*), which extends from the insertion of the recti to the optic nerve toward the interior of the eye. If one gropes about for the lens with a loop in an eye almost devoid of its contents one's instrument may injure the retina and the choroid on the apex of the anterior fold, which will cause hemorrhage and loss of the eye. At the session of the Ophthalmological Society in Vienna in 1925 my father demonstrated such injuries. It is evident, therefore, that in such cases one must be exceedingly cautious in using the loop and avoid passing it into the eye too far.

SUMMARY

All that I have been able to do in this article has been to touch on certain small fields of pathologic anatomy and to emphasize their importance for the operator. The great gain to be derived from the study of anatomic preparations, particularly of eyes operated on and observed by oneself, is self-evident; nevertheless many ophthalmologists, particularly those of the younger generation, seem inclined to neglect such study. It is possible, therefore, that these observations will stimulate some to devote more time to this important chapter, which has so great practical value.

USE OF VASODILATORS IN TREATMENT OF RETROBULBAR NEURITIS

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NEW YORK

As the intravenous administration of a 10 per cent solution of sodium nitrite was successful in bringing about a rapid return of vision in cases of tobacco amblyopia,[1] it seemed logical to discover whether or not a similar beneficial result would follow its use in cases of other types of retrobulbar neuritis.

The theory that tobacco amblyopia might be of vascular origin was developed from earlier work of Sourdille, Schieck, Aubaret and Sedan, Horniker, Imre and others by Pflimlin in 1930. The results following the use of sodium nitrite in the treatment of tobacco amblyopia which were obtained by Pflimlin and other workers (Duggan, Laszlo, Shannon and McAndrews and Cordes and Harrington) have been given at length in the aforementioned reference, together with a description of the composition of the preparation used.

In the nine cases of retrobulbar neuritis described in this paper sodium nitrite was used intravenously. In cases 1 and 6 each of the first three injections contained 0.04 Gm. of sodium nitrite. All other injections contained 0.1 Gm. In four of the nine cases the retrobulbar neuritis was a manifestation of multiple sclerosis.

REPORT OF CASES

CASE 1.—M. McG., a man aged 31, suffered from acute bilateral retrobulbar neuritis. The patient, a moderate drinker and smoker, had been aware of failing vision for two months; it was associated with some drowsiness, but no headaches were present. When he was first seen, vision was 5/200 in each eye. The pupils were equal and reacted sluggishly to light. The fundi showed a slight pallor in the temporal portion of each disk, with a slight blurring of the nasal margin. There was a small, deep hemorrhage just below the right macula and near the superior temporal vessels of the left eye. By confrontation there was a dense central scotoma (10 degrees in diameter) in the field of each eye. Urinalysis and the Wassermann test of the blood gave negative results; a roentgenogram of the skull disclosed no abnormalities, and the rhinologic and neurologic examinations gave normal results.[2]

From the Herman Knapp Memorial Eye Hospital.

1. Duggan, W. F.: The Vascular Basis of Tobacco Amblyopia, Arch. Ophth. **13**:1059 (June) 1935.

2. Unless stated to the contrary in the cases described in this report, neurologic examinations were made by Dr. Berman, and rhinologic examinations, by Dr. Hampton Howell.

This patient received six daily injections of sodium nitrite. After the last injection vision was 20/200 in each eye. One week later it was 12/200 in each eye, after which the patient failed to return for further examination.

CASE 2.—M. O., a woman, aged 30, suffered from acute unilateral retrobulbar neuritis. This patient, who was referred to me by Dr. T. M. Trousdale, complained of a shadow before the right eye which had been present for four days. She had been in excellent health and did not state having had a recent cold in the head or any general disease.

On examination vision in the right eye was 20/50—, and the pupil reacted to light and in accommodation. The external examination gave negative results, and the media were clear. Ophthalmoscopically, the edges of the disk were a little indistinct, the retinal arteries were narrowed and the veins were markedly engorged. A tangent screen field (fig. 1 *A*) revealed an annular scotoma connected with an enlarged blindspot for a 5 mm. white test object at 1,000 mm.; the field for a 2 mm. white test object at 1,000 mm. was limited to a small area just temporal to the fixation point, and a 5 mm. red test object was not seen at all.

In the left eye vision was 20/20; the fundus was similar to that of the right eye, and the field showed no abnormalities.

The Wassermann reaction of the blood was negative; a neurologic examination showed only a slight hyperactivity of the deep reflexes; a rhinologic examination (by Dr. Trousdale) gave negative results, and a roentgenologic examination (by Dr. Snowden) revealed no abnormality of the sinuses or of the sella turcica.

The patient was given six daily intravenous injections of sodium nitrite by Dr. Trousdale. On the seventh day, vision in the right eye was 20/20—; the field (fig. 1 *B*) showed an arcuate defect above, connected with the blindspot, and the fundus was unchanged.

The patient was then seen at regular intervals for the next seven months, and no further change in vision was noted. When she was last seen (seven months after her attack), vision was 20/20; there was a suggestion of pallor of the right disk, down and out; the retinal veins were still distended, and the field (fig. 1 *C*) showed an absolute arcuate defect. The limits of the field for a 5 mm. red test object at 1,000 mm. were within normal. Another neurologic examination made at this time also gave negative results.

The etiology could not be determined in this case. The disorder resembled a variety of retrobulbar neuritis classified by Traquair [3] as acute axial neuritis.

CASE 3.—E. T., a man aged 49, suffered from acute unilateral retrobulbar neuritis. This patient, who was referred to me by Dr. T. M. Trousdale, complained of a blur in the nasal half of the left field of vision, which had been present for two weeks but had improved slightly since its onset. His past history was irrelevant except for a severe cold in the head about two months before the onset of blurred vision. The patient had smoked thirty cigarets daily for eight years and had drunk three or four high-balls daily for about two and a half years. A medical examination gave essentially negative results except for the fact that the blood pressure was 165 systolic and 100 diastolic; urinalysis and the Wassermann test of the blood gave negative results. Dr. Trousdale reported that

3. Traquair, H. M.: Introduction to Clinical Perimetry, ed. 2, London, Henry Kimpton, 1931, p. 138.

the patient's nose and sinuses were clinically normal and that a roentgenogram of the sinuses disclosed no abnormalities.

Vision in the left eye was 20/30 —4, and the pupil reacted normally; ophthalmoscopic examination revealed a normal fundus. The field (fig. 2*A*) showed a large nasal scotoma for a 5 mm. white test object at 1,000 mm. and a normal blindspot. Vision in the right eye was 20/20, and the field was normal.

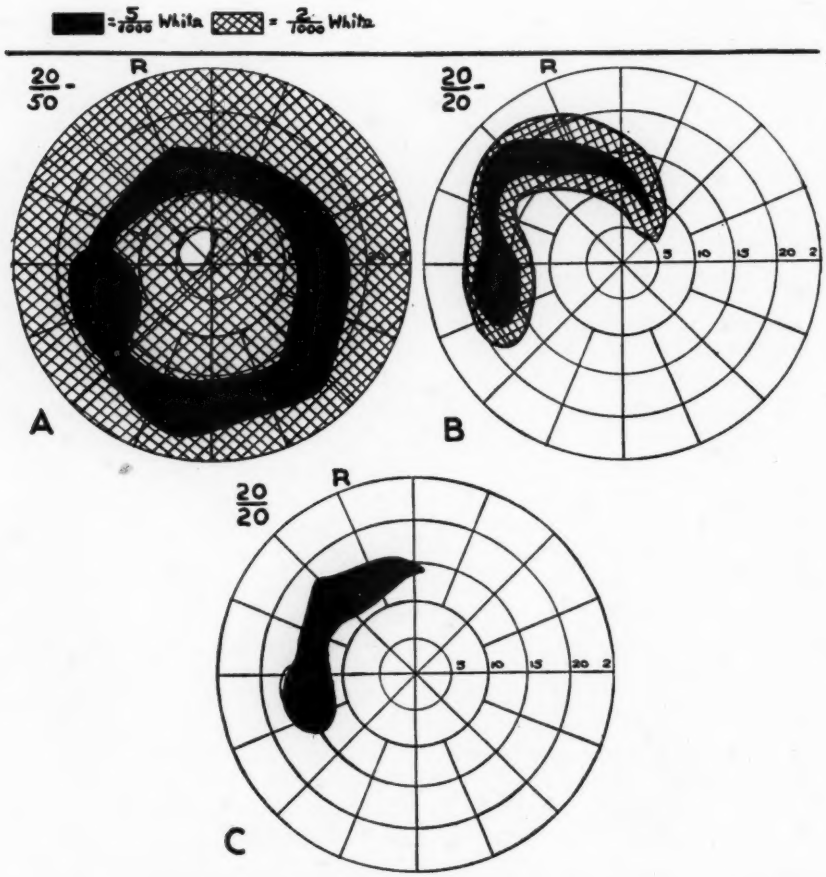

Fig. 1 (case 2).—*A*, right field before treatment with sodium nitrite. Vision in the left eye was 20/20, and the left field was normal. The illumination used for determination of all the fields shown was either daylight or 10 foot-candles. *B*, right field one day after the patient had received six injections of sodium nitrite. The stimuli used were the same as those used for the determination of the field shown in figure 1. *C*, right field seven months after the determination of the field shown in figure 1 *B*. The defect shown was for a 5 mm. white object at 1,000 mm. The scotoma was the same size for a 1 mm. white test object.

This patient received six daily injections of sodium nitrite. When he was seen again by me four days later, vision in the left eye was 20/25 —3, and the field (fig. 2*B*) showed only two tiny paracentral defects for a 0.5 mm. white object at 1,000 mm.

The patient was advised to have further injections, but after taking four he discontinued his visits. Word was received three months later that vision was 20/40. Seven months after the onset of the disorder he reported that vision in his left eye was as good as ever. He refused at this time to have his vision or fields examined or to undergo a neurologic examination.

Whether or not the disorder in this case was due to multiple sclerosis could not be determined. The temporary rapid improvement in vision and in the defect in the field during treatment was marked.

CASE 4.—N. P., a woman, aged 26, suffered from acute unilateral retrobulbar neuritis. This patient, who was seen first on Feb. 8, 1935, had noticed blurring of vision in her right eye for four days. She had also had a severe frontal headache for nine days and had been receiving intranasal treatment for inflammation

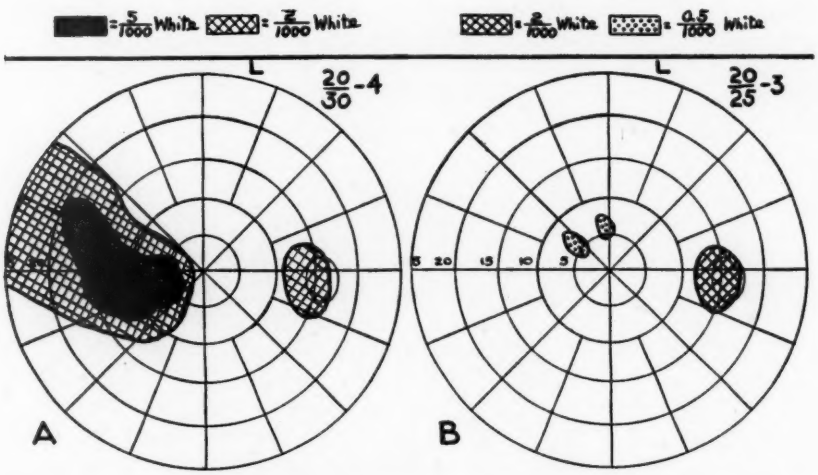

Fig. 2 (case 3).—*A*, left field before treatment with sodium nitrite. Vision in the right eye was 20/20, and the right field was normal. *B*, left field four days after the patient had received six daily injections of sodium nitrite. Except for the two paracentral scotomas the extent of the field for a 5 mm. red test object was the same in the left as in the right eye.

of the right frontal sinus for seven days. Vision was 20/20 in each eye at the time the headache began.

When the patient was seen on Feb. 8, 1935, vision in the right eye was 20/50 + 2, the pupil reacted normally and the fundus was normal except for a definite engorgement of the retinal veins, involving especially the inferior branches. The temporal half of the right disk was paler than the corresponding portion of the left disk. A tangent screen field (fig. 3) showed an arcuate scotoma continuous with the upper pole of the blindspot and a moderate constriction of the field for a 5 mm. red test object at 1,000 mm. Vision in the left eye was 20/20, and the field was normal.

The patient received eight intravenous injections of sodium nitrite from February 8 to February 14 (two injections were given on February 10). On February 10, after the third injection, vision in the right eye was 20/30—3. On Feb-

ruary 11, after the fifth injection, vision in the right eye was 20/40, and the defect in the field, while slightly larger than when the patient was first seen, was 12 degrees away from the fixation point. On February 13, before the seventh injection, vision was 20/25 —3; two hours after the seventh injection, it was 20/20 —3, the arcuate defect had completely disappeared, the blindspot was normal and the field when examined with a 5 mm. red test object at 1,000 mm. was normal.

When the patient was last seen, on March 22, 1935, vision in and the field of the right eye were normal; the fundus still showed a moderate engorgement of the inferior temporal veins.

On February 9, the right sphenoid sinus was opened by Dr. George Brighton, and a few mucous shreds were washed out. This procedure was repeated on February 11. A roentgenogram of the sinuses showed normal conditions.

A neurologic examination on February 15 by Dr. S. C. Burchell revealed no signs of multiple sclerosis.

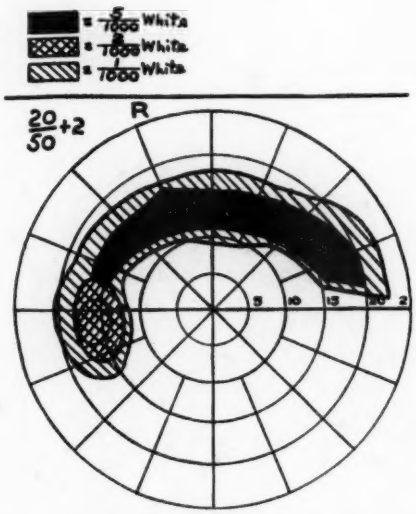

Fig. 3 (case 4).—Right field before treatment with sodium nitrite. Vision in the left eye was 20/20, and the left field was normal.

The patient had also applied a "heat box" (a device containing four electric bulbs and fitted over the patient's head) for fifteen minutes three times a day on February 12, 13 and 14.

While in this case the patient did not receive vasodilator treatment alone, the return of normal vision with complete disappearance of the scotoma on the sixth day of such treatment contrasts favorably with the results obtained in two other cases of acute unilateral retrobulbar neuritis, observed at about the same time, in which the only treatment used consisted of opening and irrigating one or more sinuses. In the first case vision and the field were normal twelve days after operation on the sinuses; the antrum on the affected side contained pus, and the sphenoid sinuses were normal. In the second case, vision and the field became normal twenty-one days after the operations on the sinuses; the

antrum on the affected side was normal (the washings returned clear), and the sphenoid sinuses were not opened. Each of the patients had a severe cold in the head before loss of sight, and neither showed any clinical signs of multiple sclerosis.

At a recent meeting of the Hungarian Ophthalmological Society, Dallos,[4] in discussing Horay's paper, stated that the rapid healing in many cases of retrobulbar neuritis is evidence against the presence of severe organic changes and points to a vascular nutritional disturbance of the optic nerve.

Benedict [5] also expressed the opinion that operation on the sinuses brings about improvement in these cases by means of the hyperemia resulting from the operative trauma, packing and absorption of blood.

CASE 5.—O. S., a man aged 44, suffered from chronic bilateral retrobulbar neuritis. This patient had noticed spots before his left eye ten years before he was seen; this was followed by a permanent blurring of his central vision. Two years later he discovered a similar blur just below the point of fixation in his right eye. These "spots" had remained relatively unchanged since then except that they seemed to enlarge slightly when the patient was under any nervous strain and were smallest when he felt at ease mentally. His past history was irrelevant except for an appendectomy twenty-five years earlier, followed by adhesions, so that the patient found it necessary to take a mild catharsis or an enema daily. He had smoked four cigars daily for many years. His teeth were in good condition; the blood pressure was 110 systolic and 76 diastolic, and his general physical condition was good.

When the patient was first seen, on March 6, 1934, vision was 20/20 in the right and 20/100 in the left eye. There was a low astigmatic error of refraction. The pupils reacted normally, and the media were clear. Both optic disks were normal except for marked whiteness of the floor of each physiologic cup; this was regarded as possibly indicating partial atrophy. The retinal arteries appeared narrowed, and their smaller branches were rather tortuous. In the left fundus there were also a few tiny chorioretinal lesions along the branch of the inferior temporal artery which ran up toward the macula. Both maculae seemed to be normal.

A tangent screen field revealed in the right eye a scotoma with a sloping edge, 3 degrees below the fixation point; in the left eye there was a similar defect, more centrally located, which extended to the upper boundary of the field (fig. 4*A*). (It was considered that the upper portion of the scotoma in the left eye was probably due to the old chorioretinal lesions described.)

As the patient's rhinologic history was noncontributory it was decided to give him sodium nitrite as a test of the drug and then to make an examination of his sinuses at his convenience.

Between March 12 and March 18, 1934, the patient received six intravenous injections of sodium nitrite. There was gradual improvement of vision in the

4. Dallos, in discussion on Horay, G.: Zur Klinik der akuten retrobulbaren Neuritis, Klin. Monatsbl. f. Augenh. **93**:397, 1934.

5. Benedict, W. L.: Retrobulbar Neuritis and Disease of the Nasal Accessory Sinuses, Arch. Ophth. **9**:893 (June) 1933.

left eye, and immediately after the last injection vision in that eye was 20/40 —3, and the defects in the fields showed a moderate decrease in density.

When seen again, on March 27, the patient reported that he had had a severe cold in the head for a week and that vision in the left eye had become worse during the last three days. At that time vision was 20/20 in the right and 20/100 in the left eye.

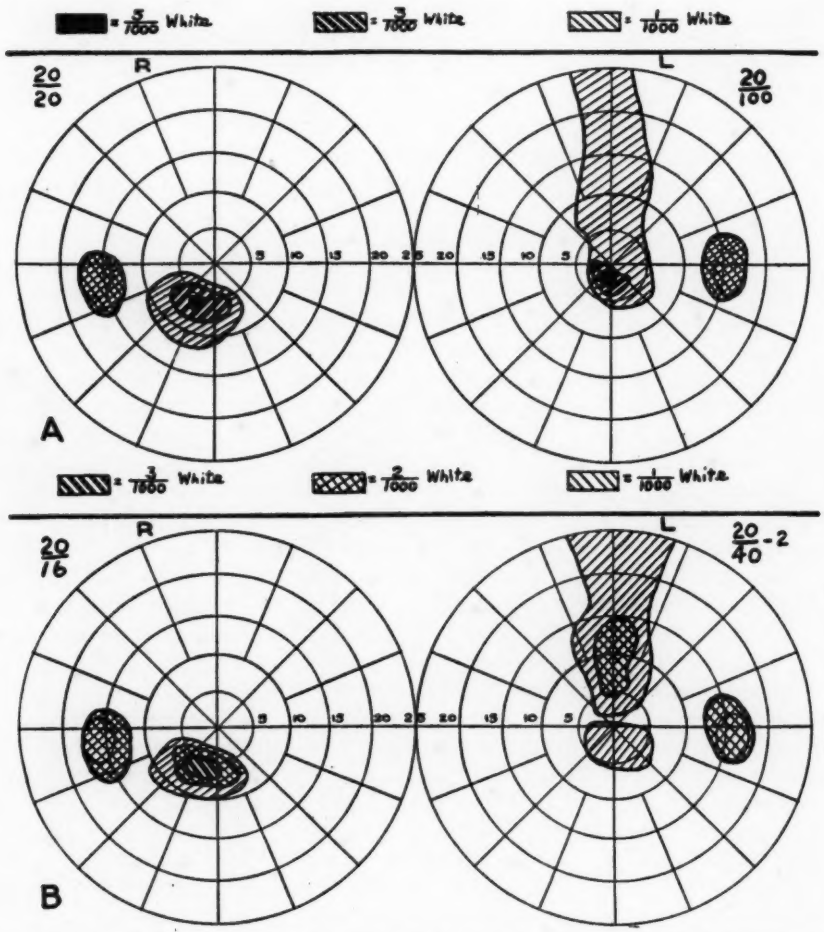

Fig. 4 (case 5).—*A*, tangent screen fields made on March 6, 1934, before treatment with sodium nitrite. The upper portion of the left scotoma, which was not examined with any other than a 1 mm. white test object at this time, always showed a denser area in all following determinations of fields, similar to that shown in figure 4 *B;* hence it may be assumed that one was also present at this time. *B*, fields on March 20, 1935. The patient had received twenty-five injections of sodium nitrite during the first nine weeks following the determination of the fields shown in figure 4 *A*. The lower scotoma in the left eye could not be detected with a 2 mm. or a 3 mm. test object at this time.

The patient was then seen by Dr. E. R. Faulkner, who found bilateral ethmoiditis with some involvement of the sphenoid sinuses which was apparently an acute exacerbation of an old chronic condition.

The sinusitis was treated by Dr. Faulkner during the next month. From March 27 to March 31 the patient also received five more injections, vision in the left eye improving to 20/50 —2 after the last injection. This was maintained until May 12, 1934, the patient having received fourteen more injections of sodium nitrite in the intervening period.

The patient was seen next on Aug. 9, 1934, at which time he said that after adjustment of certain marital and financial difficulties which had been a source of worry for many months, vision in his left eye had improved still more. At this time vision in that eye was 20/40, and both the right and the lower portion of the scotoma in the left eye were less dense; no defect could be discovered by examination with a 5 mm. white test object.

On Dec. 12, 1934, vision in the left eye was 20/30 —2. The patient was seen again on March 20, 1935, at which time vision was 20/16 in the right and 20/40 —2 in the left eye. A determination of the fields at this time (fig. 4 *B*) contrasted favorably with that made at the time of the patient's first visit (fig. 4 *A*). A recent neurologic examination by Dr. S. C. Burchell revealed no evidence of multiple sclerosis or of any other generalized disease of the nervous system. When the patient was last seen, on Dec. 8, 1935, vision in the left eye was 20/30 —3.

In this case the disorder was apparently a chronic retrobulbar neuritis which was possibly due originally to bilateral ethmoiditis, as after vision had improved following the use of sodium nitrite an acute exacerbation of the old sinusitis was followed by another decrease in vision. Treatment of the sinusitis supplemented by further injections of sodium nitrite rapidly restored vision in the left eye to that which had been previously attained. After certain complicating mental factors which had tended to upset the patient's mental poise had been disposed of, vision improved slightly more. While improvement in vision from 20/100 to 20/30 —3 is not a remarkable gain, the fact that any improvement was obtained in what was, according to the patient's history, an old condition is of some importance, and the possibility of improvement would be particularly important if such a condition should exist in a person's only eye.

In the following four cases the retrobulbar neuritis was apparently one manifestation of multiple sclerosis. Adie [6] expressed the belief that in from 30 to 50 per cent of all cases acute retrobulbar neuritis is due to multiple sclerosis. This series of nine cases is so short that one could not hope for an exact duplication of Adie's figures, but the parallelism is interesting.

CASE 6.—J. J., a man aged 29, suffered from acute unilateral retrobulbar neuritis and multiple sclerosis. This patient, who was seen on Feb. 16, 1932, by Dr. Arnold Knapp, stated that he had an attack of sudden, complete blindness in the left eye fifteen days previously, with a slight return of vision since that time. The past history was irrelevant except for an attack of rheumatism one year before the onset of the ocular disturbance.

6. Adie, W. J.: The Aetiology and Symptomatology of Disseminated Sclerosis, Brit. M. J. **2**:997 (Dec. 3) 1932.

On examination, vision in the left eye was 2/200 (excentric); the pupil reacted to light and in accommodation, the media were clear, the temporal portion of the disk showed a definite atrophy and the field showed a large scotoma, about 10 degrees in diameter, for a 1 cm. test object, by confrontation.

Vision in the right eye was 20/20; the fundus was normal, and the field, tangent screen, was normal.

The urine showed a positive reaction for albumin on one occasion; the Wassermann reaction of the blood was negative; rhinologic, dental and neurologic examinations gave negative results, and the spinal fluid showed no abnormalities. Injections of foreign protein and drainage of the sphenoid sinus were suggested by the neurologist.

On February 19 vision in the left eye had improved, amounting to 12/200. The patient then received three injections of a preparation of sterile milk during the next six days, after which, on February 26, vision was 20/200, and a tangent

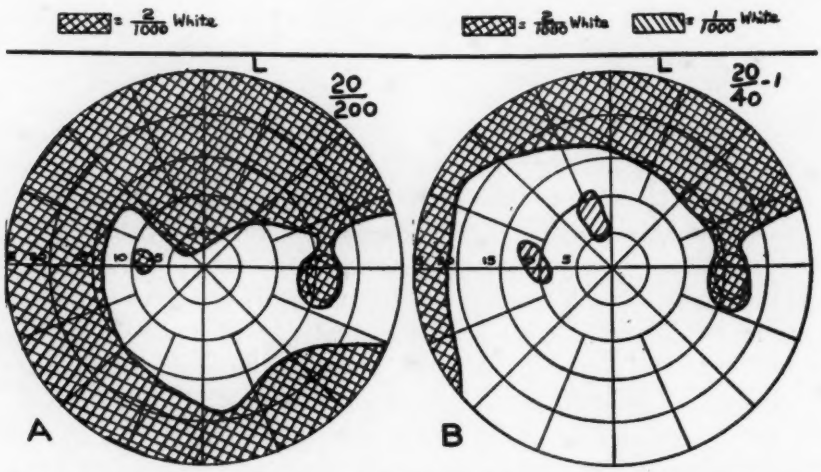

Fig. 5 (case 6).—*A*, left field on Feb. 26, 1932, twenty-five days after the onset of the attack, and immediately before treatment with sodium nitrite. Vision in the right eye was 20/20, and the right field was normal. *B*, left field on March 9, 1932, one week after the patient had received six daily injections of sodium nitrite.

screen field showed a marked contraction with a small paracentral scotoma (fig. 5 *A*).

The patient then received six daily intravenous injections of sodium nitrite from February 26 to March 2. After the sixth injection, vision in the left eye was 20/50 —1, and the field (fig. 10) showed a further improvement. Two weeks later (March 16) vision was 20/30, and five weeks later (May 6) it was 20/25, and the paracentral scotomas shown in figure 5 *B* had disappeared. Six and a half months later (September 14) vision was still 20/25, and the field showed only a slight defect in the upper nasal portion for a 2 mm. white test object at 1,000 mm.; the defect was not connected with the blindspot. On Dec. 30, 1932 (ten months after treatment), vision in and the field of the left eye were unchanged. In making a neurologic examination at this time Dr. Berman found hyperactive deep reflexes, lively abdominal reflexes, an Oppenheim sign on the right and a Rossolimo reflex bilaterally; a Babinski sign could not be elicited. Dr. Berman thought that these

findings were suggestive of a mild multiple sclerosis. In June 1933 the deep reflexes were less hyperactive, and the only pathologic reflex was a Rossolimo sign on the right.

In March 1934 vision was 20/20 —4 in the left eye. The field was not determined. During all the time he was under observation the patient showed atrophy of the temporal portion of the left disk.

The results in this case were not a true test of the value of vasodilator therapy as its use was not started until twenty-five days after the onset of the attack of retrobulbar neuritis. However, since vision improved to only 20/200 during this time while it improved from 20/200 to 20/50 during the six days vasodilator treatment was administered and showed a further improvement to 20/30 during the next two weeks, it seems that the vasodilator therapy effected a more rapid visual improvement than might have otherwise occurred.

The findings in this case are also interesting because the acute retrobulbar neuritis preceded any other signs suggestive of multiple sclerosis by about eleven months.

CASE 7.—R. K., a man aged 29, suffered from acute unilateral retrobulbar neuritis and multiple sclerosis. This patient, who was presented before the Section of Ophthalmology of the New York Academy of Medicine on Jan. 16, 1933,[7] was seen on July 1, 1932, because of a complaint of sudden and complete loss of sight in the left eye which had occurred eighteen days before. He had also suffered from multiple sclerosis for two years.

On examination vision in the left eye was 3/200; the pupil showed hippus; the fundus was normal except for pallor of the temporal portion of the disk, and the field, by confrontation, showed a central scotoma about 15 degrees in diameter for a 10 mm. test object (nine days earlier vision had been restricted to perception of hand movements in the extreme peripheral field, and the pupil had not reacted to light). Vision in the right eye was 20/20 (corrected), and there were no abnormal findings except moderate myopia. The most prominent symptom of multiple sclerosis at this time was a marked fatigability on exertion. The Wassermann reaction of the blood was negative, and there was no infection of the sinuses.

From July 1 to July 6 the patient was given six daily intravenous injections of sodium nitrite. Vision in the left eye showed improvement after each injection and was 20/25 after the sixth injection. The patient also volunteered the information that he was able to run after a trolley-car for the first time in two years.

Two weeks later he returned, stating that vision in his left eye had been failing again for two days. At this time vision in the left eye was 20/70 —; the temporal portion of the disk showed definite atrophy, and a tangent screen field revealed a large central scotoma (fig. 6 *A*). As the patient disliked to submit to venipuncture, he was given three daily inhalations of amyl nitrite. Vision in the left eye improved, amounting to 20/30 —2 after the first inhalation and to 20/25 — after the third inhalation. Five days later (July 27, 1932) vision in the left eye was 20/30 + 1, and the defect in the field had improved (fig. 6 *B*).

7. Duggan, W. F.: Unilateral Loss of Vision in a Case of Multiple Sclerosis: Treatment with Vasodilators, Arch. Ophth. **10**:142 (July) 1933.

The patient was next seen on Feb. 3, 1933, approximately six months later, at which time vision in his left eye was 20/20; his field showed only a slight enlargement of the blindspot, nasally, and a 10 mm. red stimulus at 1,000 mm. was perceived only in the lower nasal portion of the field. On June 27, 1934, and on Sept. 4, 1935, vision in the left eye was unchanged; the blindspot was normal; the field for a red test object was approximately normal, and there had been no recurrence of the multiple sclerosis, whereas, between June 1930 and March 1932 several exacerbations of the disease had occurred.

On Oct. 28, 1935, the patient returned, complaining of a blur before the right eye, which had been present for two days. He had noticed some loss of bladder control for one week, and he stated that he had increased his consumption of tobacco to forty cigarets daily in the preceding two months.

Vision in the right eye was 20/70; the pupillary reactions were normal; the optic nerve was normal, and a tangent screen field revealed a dense cecocentral

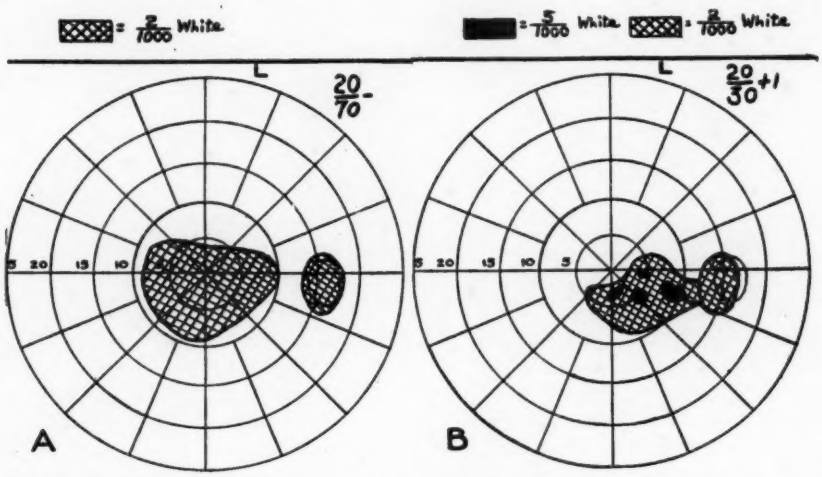

Fig. 6 (case 7).—*A*, left field on July 20, 1932, two days after a second attack of retrobulbar neuritis. The scotoma was approximately the same size for a 5 mm. white object. Fixation was poor. *B*, left field on July 27, 1932, five days after three daily inhalations of amyl nitrite.

scotoma for a 5 mm. white test object at 1,000 mm., chiefly in the lower temporal portion of the field; a 10 mm. red stimulus at 1,000 mm. was perceived only in the upper nasal quadrant. Vision in the left eye was 20/20—3; the left fundus and field were unchanged.

From Oct. 28 to 30, 1935, the patient received three intramuscular injections (100 mg.) of acetylcholine. On November 1 vision in the right eye was 20/200. As he was getting definitely worse and as vision had improved rapidly after the use of sodium nitrite in 1932, during the attack involving the left eye, treatment with sodium nitrite was instituted. From November 1 to November 8 the patient received five intravenous injections of sodium nitrite and in addition used five ampules of amyl nitrite at home. Vision in the right eye was 20/30 + 3 on Nov. 8, 1935, one hour after the fifth injection. The field showed a small paracentral scotoma for the 1 and 2 mm. white test objects.

On Nov. 10, 1935, vision in the right eye was 20/20 —3; no scotoma could be detected with the 1 mm. white stimulus at 1,000 mm., and the patient volunteered the information that his bladder control had definitely improved.

When the patient was last seen, on Feb. 5, 1936, vision in the right eye was 20/20 —3; the disk showed a barely perceptible pallor in the temporal region; the field showed no scotoma for a 1 mm. white stimulus at 1,000 mm., and the boundaries of the field for a 10 mm. red object at 1,000 mm. showed only a slight contraction down and out. On July 22, 1936, the status of the right eye was unchanged. Moreover, the right optic nerve did not show a marked temporal pallor; this may have been due to the fact that treatment was instituted early. The left eye was unchanged during all this time.

Acetylcholine was apparently of no value in combating the attack in the right eye, whereas after five injections of sodium nitrite, together with medication with amyl nitrite, which the patient used at home, vision became normal, and the scotoma completely disappeared nine days after the use of sodium nitrite was instituted.

CASE 8.—R. L., a man aged 27, suffered from unilateral optic atrophy following acute retrobulbar neuritis and from multiple sclerosis. This patient, who was first seen on April 8, 1933, complained that vision in the right eye had been poor for three years and that twitching (?) of the eyes had been present for one year and difficulty in walking for six months.

Vision in the right eye was 20/100 —1 (not improved), and there was atrophy of the temporal portion of the optic nerve on the right. Vision in the left eye was 20/30, and the optic nerve was normal on the left. There was also a fine horizontal nystagmus.

The diagnosis of multiple sclerosis was made by Dr. Berman on the basis of the following observations: nystagmus, hyperactivity of the deep reflexes, diminution and ease of exhaustibility of the abdominal reflexes, absence of cremasteric reflexes, Babinski sign on the left and an equivocal Babinski sign on the right.

Unfortunately, this patient was not seen by me until after he had received fourteen daily intravenous injections of sodium nitrite so that no evidence of the condition of the field before treatment is available.

However, vision in the right eye improved to 20/70 after the third injection and to 20/50 after the ninth injection.

On April 23, 1933, two days after the fourteenth injection, vision was 20/50 in the right eye and 20/20 —2 in the left. Examination of the field, at this time (fig. 7 *A*) showed a rather large paracentral scotoma in the right eye, while the left field was normal as examined with a 1 mm. white and a 10 mm. red stimulus at 1,000 mm.

From May 19 to July 11, 1933, the patient received sixteen more injections, and vision in the right eye gradually improved, amounting to 20/30—3. On September 13, after the patient had received four more injections, vision in the right eye was 20/25. On Feb. 26, 1934, vision in the right eye was 20/30—3, and examination of the field at this time (fig. 7 *B*) showed a definite decrease in the size of the scotoma. From then until April 27, 1934, vision in the right eye varied between 20/40—3 and 20/30—1 (six more injections of sodium nitrite were given during this time).

The findings in this case are deemed of importance for two reasons: 1. At the time case 7 was first reported the objection was offered that patients with acute retrobulbar neuritis associated with multiple sclerosis

always recover their vision even without treatment. Dr. David Wexler then reported a case in which acuity of vision had not been recovered beyond 20/200, and he stated that any agency whereby patients with this condition could be assured of a return of vision to normal was worth while. Case 8 of this series is apparently one in which the patient did not recover normal vision spontaneously. 2. Even if vision has not returned to normal in cases in which such a condition exists, it seems that when the scotoma has a relatively sloping edge (as in figure 7 *A*), adequate and prolonged treatment with vasodilators offers a chance for at least a partial return of vision.

Case 9.—J. S., a man aged 23, suffered from partial atrophy of the optic nerve following loss of blood (?) and from multiple sclerosis. This patient, who was

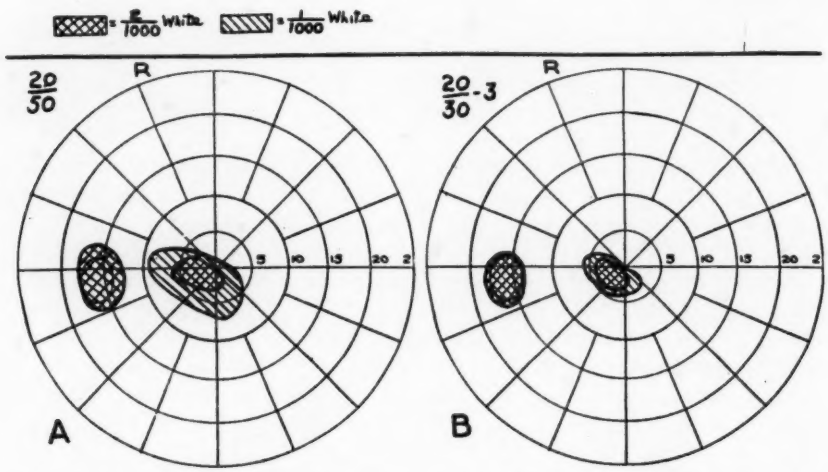

Fig. 7 (case 8).—*A*, right field after the patient had received fourteen injections of sodium nitrite. Vision was 20/100—1 before treatment. Vision in the left eye was 20/20—2 and the left field was normal. *B*, right field ten months after determination shown in figure 7 *A*. The patient received thirty-four injections of sodium nitrite in all, and twenty of them were received after the examination of the field, results of which are shown in figure 7 *A*.

presented before the Section of Ophthalmology of the New York Academy of Medicine on April 15, 1935, was first seen by me on March 11, 1935, at which time he stated that he had suffered from poor vision in both eyes for about two years. In March 1933 within forty-eight hours he gave 500 cc. of blood twice as a donor. Within two weeks he noticed a gradual loss of vision in both eyes, which was most marked two months after he had acted as donor. He had been exposed to no poisons; there had been no recent illness; he had smoked twenty cigarets daily for seven years, and he used no alcohol. The family history was also irrelevant. Dr. Douglas furnished the information that in May 1934 vision was 20/30 in each eye; in January 1935 it was 20/200 in each eye; on Feb. 4, 1935,

it was 20/50 +2 and 20/100 —1 in the right and in the left eye, respectively, and on Feb. 6, 1935, it was 20/30 —2 and 20/100 in the right and in the left eye, respectively.

When the patient was first seen at the Herman Knapp Memorial Eye Hospital, on March 11, 1935, vision was 20/70 —1 in the right and 20/200 in the left eye and was not improved by glasses. The media were clear; the maculae were normal, and there was definite atrophy of the temporal portion of the optic nerve in each eye.

Examination of the field on the tangent screen at 1,000 mm. showed, for the right eye, a paracentral scotoma with a moderately steep edge for 1, 2 and 5 mm. white test objects. The scotoma in the left eye was larger, cecocentral and more difficult to chart accurately (fig. 8 *A*). A 5 mm. red object was seen only in a small patch nasally by either eye.

Examination of the blood showed 4,400,000 red cells per cubic millimeter, and the hemoglobin content was 79 per cent. The white cells were normal in number and distribution.

The patient received ten daily intravenous injections of sodium nitrite between March 18 and March 27, 1935; vision in the right eye improved to 20/40 +2, while that in the left eye remained unchanged. From April 1 to April 3 the patient received three more injections, after which vision was 20/30 in the right eye and 20/100 in left. Examination of the fields at this time (fig. 8 *B*) showed a slight but definite decrease in the size and density of the scotoma in the right while that in the left eye had apparently increased slightly. There was, however, a definite improvement in the field for reaction to a 5 mm. red test object in both eyes.

On April 15 (twelve days later) vision was 20/30 —3 in the right and 20/100 —1 in the left eye. At this time the temporal portion of each disk was definitely pinker, so that there seemed to be only a pallor of the temporal portion of the left disk. Examination of the field at this time gave results similar to those shown in figure 8 *B*.

On April 24, 1935, vision was 20/40 —3 in the right and 20/100 —1 in the left eye. After another injection of sodium nitrite vision in the right eye improved to 20/30 —3, but there was no change in the vision in the left eye. On May 1 vision was 20/50 and 20/200 in the right and in the left eye, respectively.

The patient was not seen again until Feb. 26, 1936; at this time vision was 20/100 + 1 in the right eye and 16/200 in the left eye. Fourteen more injections of sodium nitrite did not appreciably improve his vision at this time.

A roentgenogram of the sinuses made on April 8, 1935, revealed marked cloudiness of both antrums and of the ethmoid cells on the right side. The sphenoid, frontal and left ethmoid sinuses were normal, and the inferior turbinate bones were enlarged. The roentgenologic diagnosis was: polysinusitis with thickening of the mucous lining of the cavities; no evidence of exudate.

A clinical rhinologic examination by Dr. Osgood on April 15, 1935, revealed no discharge from the sphenoid or ethmoid sinuses. Transillumination of the antrums and frontal sinuses showed no abnormalities.

A neurologic examination by Dr. S. C. Burchell on April 25, 1935, showed (1) bilateral atrophy of the temporal portion of the optic nerves, (2) a well sustained lateral nystagmus (this was not demonstrable on April 15), (3) a spastic unsteady gait, (4) a Romberg sign, (5) generalized hyperreflexia, (6) a bilateral Hoffman sign, (7) exhaustible ankle clonus and (8) an equivocal Babinski sign bilaterally.

(When the patient was first seen, in March 1935, he was suffering from a recent injury to his right knee, so that at the clinic it was not possible to demonstrate a Romberg sign or any disturbances in gait.)

The findings in this case are of interest because of the bilateral partial loss of sight, which began not later than fourteen days after the patient had donated at least 1,000 cc. of blood, the bilateral atrophy

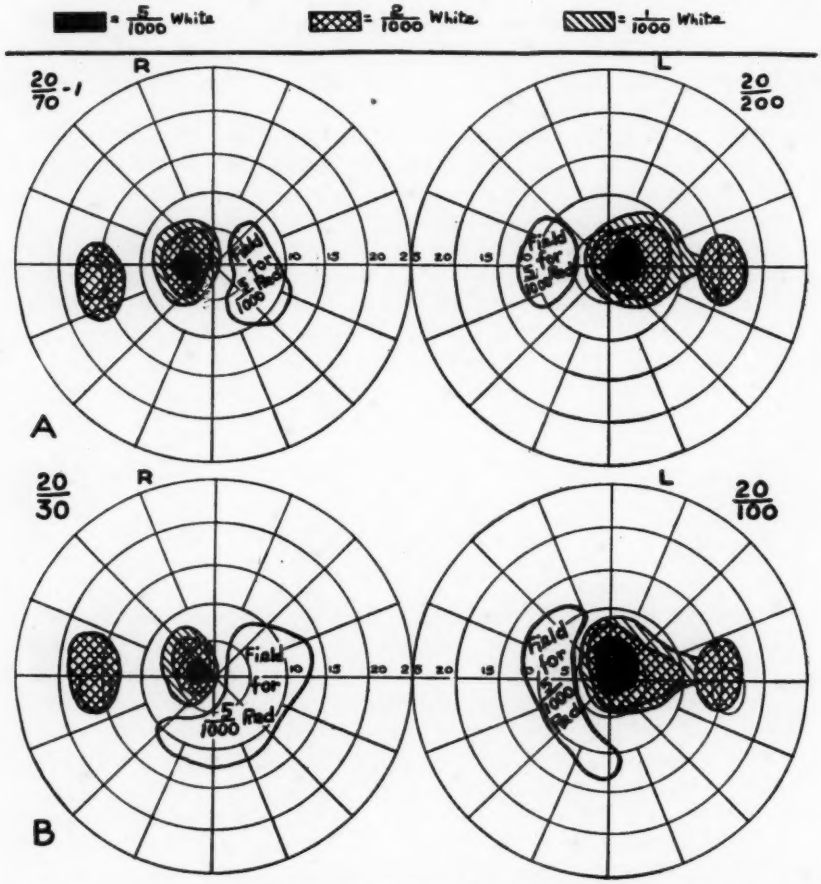

Fig. 8 (case 9).—*A*, fields on March 15, 1935, before treatment with sodium nitrite. Because of poor fixation, the left scotoma was difficult to map. The defects in the fields are strikingly similar to those found in tobacco amblyopia. *B*, fields on April 3, 1935, after the patient had received thirteen injections of sodium nitrite. The right scotoma is definitely smaller, and the fields for red test objects have improved. The left scotoma is slightly denser (?).

of the temporal portion of the optic nerve with bilateral defects in the fields (resembling those caused by tobacco amblyopia) which point to a lesion in either the optic nerves or the optic chiasm and the discovery of definite signs of multiple sclerosis in a recent neurologic examination.

It is a well known physiologic fact that after a moderate or a large hemorrhage the blood pressure tends to be maintained at its normal level. This is accomplished (1) by withdrawal of tissue fluid into the circulation to make up the lost volume, as evidenced by a decrease in the red cell count and the hemoglobin content; (2) by a constriction of the arterioles (due to the action of the sympathetic nervous system) in the regions of the body not vitally concerned in maintaining life, whereby the capacity of the vascular system is reduced; (3) by cardiac acceleration, whereby the blood which has a reduced oxygen content circulates more rapidly, and (4) by a slight but measurable swelling of the red corpuscles which undoubtedly increases the viscosity of the blood.

It is impossible to state definitely whether in this patient there developed amblyopia or multiple sclerosis with predominating ocular manifestations as the result of his loss of blood. In either case, it seems that an excessive response of the smaller arterioles in undergoing vasoconstriction as a compensation for the loss of blood was the factor primarily responsible for the clinical findings.

After this comment was written it was discovered that Mr. Eugene Wolff,[8] at the last annual congress of the Ophthalmological Society of the United Kingdom, read a paper on the causation of amblyopia following gastric and other types of hemorrhages, in which he suggested that a spasm of the arterioles due to extreme lack of oxygen might be the fundamental cause of the amblyopia. It seems to me that the volume of fluid lost at one time determines whether or not there will be an arterial or arteriolar constriction; if this is exaggerated in the retina or optic pathways, the resulting areas of localized anoxemia will lead to amblyopia, with varying pictures in the fundus and defects in the field. Also, Satanowsky and Bettinotti [9] and Hartmann and Parfonry [10] have suggested that the amaurosis resulting from a severe loss of blood is due to a vascular spasm, which when located in the retinal arteries leads to retinal ischemia.

The fluctuations in vision observed in case 9 between May 1934 and February 1935 can only support the conclusion that the disturbance was due to fluctuations in the blood supply of the optic pathways, and the temporary visual improvement in the right eye following vasodilator therapy adds further support to this opinion.

So far as I have been able to discover, this is the first case in which amblyopia has resulted in a supposedly healthy donor following the giving of blood.

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8. Wolff, E.: The Causation of Amblyopia Following Gastric and Other Hemorrhages, Brit. J. Ophth. **19**:289 (May) 1935.

9. Satanowsky, P., and Bettinotti, S.: Amaurosis Due to Ethylhydrocuprein, Arch. de oftal. de Buenos Aires **6**:589 (July) 1931.

10. Hartmann, E., and Parfonry, J.: Blindness Due to Hemorrhage Cured by Acetylcholine, Bull. Soc. d'opht. de Paris, February 1934, p. 56.

It is my opinion, which I first stated in January 1933 after observing and treating R. K. (case 7), that interference with the blood supply in the white matter of the central nervous system might be the primary cause of the disturbances characteristic of multiple sclerosis and that the myelin degeneration and glial proliferation were secondary changes due to the localized anoxemia. In corroboration of what is only a personal opinion is the fact that Royle [11] later reported four cases of multiple sclerosis in which improvement followed cervicodorsal sympathectomy, and Wetherell [12] still later reported a case of multiple sclerosis, mainly cerebellar in type, in which marked improvement occurred after a bilateral cervicodorsal sympathectomy. Also Putnam,[13] who earlier had suggested that vascular abnormalities might be the etiologic basis of multiple sclerosis, recently reported that thrombi in the cerebral venules produce a pathologic picture similar to that of multiple sclerosis.

While it is not my intention to be dogmatic about the etiology or therapy of so variable and protean a disease as multiple sclerosis, because of the excellent results obtained in case 7 as regard both vision and general symptoms, the good results obtained in cases 6 and 8 and the fair results obtained in case 9, it is my belief (1) that in cases in which acute retrobulbar neuritis is the most prominent finding intravenous treatment with a 10 per cent solution of sodium nitrite will probably restore vision rapidly, (2) that it may prevent those occasional unfortunate results in which vision does not return spontaneously to normal and (3) that if a cervicodorsal sympathectomy is contemplated (for the multiple sclerosis) a preliminary trial with intensive vasodilator therapy may demonstrate whether such a procedure will be effective or even necessary.

COMMENT

In cases of retrobulbar neuritis, whether of unknown etiology or associated with multiple sclerosis, the rapid improvement in vision (in the cases of acute involvement) following intravenous injections of sodium nitrite lends clinical support to the hypothesis that a vascular spasm is usually the immediate cause of the loss of sight, as was originally suggested by Aubaret and Sedan.[14]

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11. Royle, N. D.: Surgical Treatment of Disseminated Sclerosis, M. J. Australia **1**:586 (May 13) 1933.

12. Wetherell, F. S.: Multiple Sclerosis: Cervicodorsal Sympathectomy as a Relief Measure, J. A. M. A. **102**:1754 (May 26) 1934.

13. Putnam, T. J.: The Biological Significance of the Lesions of Multiple Sclerosis, Science **80**:295, 1934.

14. Aubaret, E., and Sedan, L.: Vascular Spasms in Ophthalmology, Clin. opht. **17**:255, 1928.

Although nasal operations on patients with disorders in which multiple sclerosis is not a factor have apparently been of value in the past in effecting a return of vision to normal, yet, as noted by Benedict,[5] operations on normal sinuses were fully as effective as those on sinuses showing definite pathologic changes. (It cannot be denied, however, that in many cases of acute retrobulbar neuritis there is a history of a recent or of a coexisting cold in the head.) As Benedict also stated, introduction of cocaine and epinephrine tampons into the nose, painting of the nasal mucosa with 2 per cent tincture of iodine and intramuscular or intravenous injection of typhoid vaccine all seemed to have a beneficial effect in restoring vision, and in association with each of these types of treatment there occurs either a local or a general alteration in the circulation. Since the trigeminal nerve conveys sense impulses to the nose, sinuses, eye, brain, etc., it is likely that the beneficial results of local nasal therapy in cases of retrobulbar neuritis are analogous to axon reflexes in their origin, whereby an irritant (traumatic or chemical) applied to one region innervated by the fifth nerve not only causes local hyperemia but sets up impulses which pass centrally to the ganglion and cause antidromic vasodilator impulses to pass down other fibers to the optic nerve (or chiasm[?]) to bring about vasodilatation there as well.

Typhoid vaccine and sodium nitrite effect vasodilatation, but by different mechanisms of course.

The factor or factors—chemical, nervous, bacteriologic and anatomic—which originally bring about the arteriolar spasm in the optic pathway in the cases of acute retrobulbar neuritis not associated with multiple sclerosis still require further investigation.

In cases of retrobulbar neuritis associated with multiple sclerosis, certain anatomic factors offer some enlightenment. Dawson [15] noted that the sites of predilection for the lesions of multiple sclerosis were related to (1) the terminal ramifications of end-arteries and (2) areas where much glial tissue is normally present, as in the chiasm. It is an established anatomic fact that the arterial supply of the central nervous system is by means of end-arteries. This fact and Dawson's conclusions account for the limitation of lesions to the central nervous system and for the particular vulnerability of the optic nerves and chiasm.

Since in the four cases of retrobulbar neuritis associated with multiple sclerosis there was also a favorable response to vasodilator therapy, it seems that the mechanism of production in nearly all cases of retrobulbar neuritis is essentially the same, namely, that the condition is brought about by the production of a zone or zones of localized anoxemia

15. Dawson, quoted by Moore, R. F.: Medical Ophthalmology, ed. 2, London, J. & A. Churchill, Ltd., 1925.

as the result of a vascular spasm. (In a few cases, endovasculitis, as noted by Sourdille,[16] or actual obliteration of capillaries, as noted by Schieck,[17] may be the causative lesion.) This idea has been previously touched on by Traquair,[18] who stated that ordinary acute retrobulbar neuritis may be a disease similar to multiple sclerosis but having only one lesion, i. e., a monosymptomatic multiple sclerosis. It is at least evident that the sites of predilection for both conditions, retrobulbar neuritis and tobacco amblyopia, are almost the same and that vasodilator therapy is of marked value in the treatment of both.

SUMMARY AND CONCLUSIONS

In eight of the nine cases of retrobulbar neuritis reported marked benefits resulted from intravenous therapy with sodium nitrite.

Improvement was manifested by a marked improvement in vision, by a marked decrease in the size and/or density of the scotoma or by both.

The time of improvement in the cases of acute involvement (cases 2, 3, 4, 6 and 7) was seven, ten, six, twenty and six and nine days, respectively, from the day treatment was started, the acuity of vision attained at the end of the respective periods being 20/20 —, 20/25 —3, 20/20 —3, 20/30 and 20/25, and 20/20 —3. (In case 7, a recurrence occurred in the left eye two weeks later. Vision improved from 20/70— to 20/25— after three daily inhalations of amyl nitrite.) Each of these patients received from five to seven injections of sodium nitrite. In case 7 the right and the left eye were separately involved, an interval of more than three years occurring between the attacks.

With regard to the cases of chronic or long-standing involvement the following observations were made: In case 5 there was improvement in vision from 20/100 to 20/40 —3 in seven days, six injections being given; in case 8 there was improvement from 20/100 —1 to 20/30 —3 in ninety-five days, thirty injections being given, and in case 9 there was improvement from 20/70 — and 20/200 to 20/30 and 20/100, respectively, in seventeen days, thirteen injections being given. In all these cases occasional injections seemed to be required after the gains noted were obtained, to maintain whatever improvement had been attained.

As permanent vascular changes are undoubtedly present in the cases of long-standing retrobulbar neuritis, a complete return of acuity of vision and of the field to normal is probably too much to expect. However, it is of some interest that vasodilator therapy apparently improves

16. Sourdille, C.: Clin. opht. **6**:280, 1900; Arch. Ophth. **30**:191, 1901.

17. Schieck, F.: Arch. f. Ophth. **71**:466, 1909.

18. Traquair, H. M.: Toxic Amblyopia Including Retrobulbar Neuritis, Tr. Ophth. Soc. U. Kingdom **50**:351, 1930.

the local circulation in the optic pathways in spite of such changes, as was evidenced by a moderate improvement in vision and by a moderate decrease in the size and density of the scotoma. Patients with long-standing involvement require a more extended course of treatment than those with acute disturbance.

The sudden and complete disappearance of a portion of (case 2), or of the whole (case 4), scotoma can be explained only by a sudden improvement in, or a return to normal of, the circulation in the visual pathway. A true inflammation is characterized by marked dilatation of blood vessels associated with edema; it is unlikely that vasodilator therapy would contribute to any sudden improvement if such a condition were present.

A permanent defect in the field (case 2, fig. 1 *C*) is best explained on the assumption that the arteriole or arterioles concerned have been permanently occluded by the formation of a thrombus.

If the assumption is correct that in most cases retrobulbar neuritis is due primarily to a vascular spasm, it seems that the diagnosis of retrobulbar neuritis is a misnomer.

While the therapeutic results were good in eight of the nine cases in this series, it is obvious that confirmation of this method of treating "retrobulbar neuritis" is essential before the hypothesis that a vascular spasm is the basic or primary cause can be accepted as proved.

It is also my opinion that similar therapy deserves a trial and should be theoretically of value, if used early, in cases of amblyopia due to thallium, optochin,[19] lead, and quinine poisoning.

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19. Dr. A. B. Reese has also suggested similar therapy in cases of amblyopia due to optochin poisoning.

BENZYL CINNAMATE IN THE TREATMENT OF TRACHOMA AND CORNEAL OPACITIES

CLINICAL AND EXPERIMENTAL RESULTS

JACOB JACOBSON, M.D.
PARIS, FRANCE

In 1919 I introduced the use of benzyl cinnamate in the treatment of tuberculosis. In order to inquire into the efficacy of this drug against tuberculosis, I used it first in the treatment of external forms of the disease, such as tuberculosis of the skin, mucous membranes and glands. These lesions being visible, it was easy to control and to follow the course of the disease. The results obtained proved worthy of interest and were confirmed by Darier and Jeanselme.[1] My subsequent researches showed that the therapeutic action of the drug is not specific for tuberculosis. Its action can be seen wherever a focus of chronic inflammation is found, regardless of the nature of the agent which produces the lesion.

It was by pure chance that benzyl cinnamate found its application in the field of ophthalmology. While treating an Algerian Arab for glandular tuberculosis, I observed that while the condition of the glands regressed the patient's eyes became more widely open. When I asked him what was the trouble with his eyes, he answered that he suffered from the disease of his country. Not being an oculist, I referred him to the National Clinic of Quinze-Vingt in Paris, where the condition was diagnosed as trachoma. Thus, experiments with benzyl cinnamate in the treatment of trachoma were begun. The first results were favorable,[2] and the French government sent me on an official mission to Tunis, a trachoma country par excellence. A special commission was established to study the question. By order of the war ministry research was carried out also among the trachomatous soldiers in the army of Tunis.

In an analysis of 244 cases of refractory trachoma, the commission reported 53 cases of slight improvement and 139 of marked improvement.[3] It is interesting to note in the records of the commission that 10 patients who formerly had to be accompanied by a guide later could go to the clinic alone. The army surgeons reported improvement in 73

Presented before the New York Academy of Medicine, Section of Ophthalmology, Feb. 17, 1936.

1. Jacobson, J.: Bull. Soc. franç. de dermat. et syph. **29**:64, 1922.
2. Chevallereau and Segal: Bull. Soc. d'opht. de Paris, 1931, p. 78.
3. Cuénod: Tunisie méd. **26**:178, 1932.

per cent of 113 cases, and in their report to the war ministry they stated that "since the resorption of the pathologic element (produced by Jacobson's method) is carried out by way of the blood stream, it appears that this process involves at the same time the cartilage, the submucosa and the conjunctival epithelium, with a tendency to a restitution ad integrum."[4]

In the course of my mission in Tunis I noted a few cases of leukoma of gonorrheal origin in which the opacity had appreciably regressed under the influence of the injections of benzyl cinnamate. Stimulated by this observation, I proceeded with experiments on animals in the laboratory.

Corneal opacities were produced in guinea-pigs and rabbits by injecting diphtheria toxin into the anterior chamber, lightly touching the iris. Diphtheria toxin was chosen because its toxicity can be accurately measured. In guinea-pigs the toxin frequently produced a purulent inflammation leading to atrophy of the eyeball. In some of the rabbits the upper part of the cornea was slightly scarified before the injection of the toxin. Acute iridocyclitis resulted, and the cornea became opaque. From seven to ten days after the injection of toxin the treatment was commenced.[5]

Ten of the twenty rabbits in which corneal opacities were produced at different times were used as controls, and in these animals the opacities remained. Seven of the ten rabbits which received treatment showed resorption in that part of the cornea which had not been scarified, and the remaining three showed only slight improvement.

Reports of favorable clinical results have been published by several authors. Bailliart[6] added at the conclusion of his report that at first he had been skeptical about this method but that later he came to appreciate its efficacy and innocuous nature.

How does benzyl cinnamate act? I have studied the properties of this drug. It is antitoxic and causes vasodilatation. It provokes leukocytosis also. However, one has no right to conclude that the therapeutic action of the drug is the result of these properties. In general, the exact mode of action of even so-called specific drugs is not known. Possibly they stimulate the defense mechanism of the body and assist the natural forces of healing. However, instead of indulging in hypotheses, one must consider the facts that have been established both experimentally and clinically: The treatment causes pronounced vascularization with vasodilatation at the site of the pathologic lesion and regression of the exudate and the chronic inflammation. Ophthalmologists have the added privilege of being able to observe this phenomenon in all its details with the slit lamp.

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4. Barral and Luc: Arch. de méd. et pharm. mil. **98**:164, 1933.
5. Jacobson, J.: Bull. Acad. de méd., Paris **110**:104, 1933.
6. Bailliart, P.: Bull. Soc. d'opht. de Paris, February 1935, p. 86.

The injection produces no general or local reaction; the tolerance is perfect. In rare instances the patient complains of slight headache and slight fatigue of short duration. A focal reaction which results from the hyperemia is noted at the site of the lesion. This hyperemia differs from pathologic hyperemia in that it is not accompanied with exudation.

The focal reaction is manifest by intermittent jumping pains, of which the patient frequently complains. Physiologically this phenomenon is very well known, particularly during menstruation. Another physiologic result of the hyperemia is an increased secretory activity of the lacrimal glands. These reactions are transitory.

DISCUSSION

DR. ERWIN JESSEL: Twenty-six patients have been treated with solution of benzyl cinnamate at the Herman Knapp Memorial Eye Hospital. All the patients showed distinct corneal opacities of more or less long standing. The opacities were due to superficial keratitis including the trachomatous type in twelve cases, to deep keratitis in ten cases and to injuries or ulcers in four cases.

The treatment consisted in three series of twelve injections each, with an interval of from eight to twelve days between series. In some cases, a fourth series of twelve injections was given. No other treatment, local or general, was used at this time. The results obtained were as follows: (1) no improvement in seven cases; (2) changes in the opacities without improvement in the vision in four cases; (3) improvement in the vision without marked changes in the opacities in five cases, and (4) improvement of both the corneal condition and the vision in ten cases.

Generally the corneas with patent deep blood vessels responded better and more quickly to the treatment than those in which the vessels had been obliterated or which had no vessels. In more than half of the corneas that improved there was observed a distinct increase in the number of capillaries, a dilatation of old vessels or a formation of new vessels. In some of the corneas of the two latter groups the dilatation or new formation of vessels did not occur until the third series of injections was being given. The corneas in which the opacities were more recent, of one year's duration or less, responded better than those in which the opacities were of long standing, although in six of the ten cases of the most improved group the lesions had been unchanged for many years, and had not responded to other types of treatment.

No disagreeable side actions or general reactions were observed. A slight pain in the affected eye was reported by several patients. The pain, which was occasionally accompanied by the formation of tears, was never severe and was described by the patient as intermittent. Most patients who had these attacks of pain were patients who improved markedly. It might be possible to explain the pain by increased filling of the corneal vessels.

DR. RAMÓN CASTROVIEJO: Through the kind cooperation of Dr. Jacobson in furnishing the drug, fourteen patients were treated at the Institute of Ophthalmology of the Presbyterian Hospital with from

twelve to thirty-six injections. Of these patients, nine had opaque or nebulous corneal transplants, three had corneal scarring following ulcers, one had chronic trachoma with extensive pannus, and the last had a staphyloma of the cornea which had been flattened by partial excision.

As to the results of treatment, no objective improvement was found in any case, and no improvement of vision was obtained in any case. The subjective improvement reported by several of the patients did not correspond with the objective observations and appeared to be due to autosuggestion.

The patients treated may not have been the best suited for Dr. Jacobson's treatment. The series is too small to enable one to evaluate definitely the worth of benzyl cinnamate in clearing up corneal opacities.

DR. ERVIN A. TUSAK: In the absence of pharmacologists, I venture to say a few words in reference to what is known about benzyl cinnamate and what the attitude of the medical profession to this compound is. According to the "United States Dispensatory," cinnamic acid is derived from storax. Storax is a resin or balsam derived from Liquidambar orientalis, a tree of subtropical countries. Storax itself must be considered an unreliable drug for many reasons, one of them being that there is a great difference between liquidambars grown in Central America, in the Near East and in Indo-China. Another reason is that the Dutch and the Austro-Italian trade use entirely different methods of technology to produce, preserve, standardize and market storax. The pharmacodynamic effect of storax is a spasmolysis of smooth muscle fibers, and therefore it has been used in gastro-enteric diseases to relieve intestinal cramps, in diseases of the respiratory organs to relieve spastic tracheal, bronchial and laryngeal coughs, in cardiac conditions to reduce high blood pressure, and in dermatoses as a disinfectant, in unguents. In all these specialties storax was found to be useless as early as 1900, wherefore the medical profession has gradually ceased to employ it or its derivatives. Compound tincture of benzoin is also a derivative of storax and is in use for the treatment of certain diseases of the larynx but with minimal therapeutic effect.

With regard to benzyl cinnamate as an organic compound, cinnamic acid is usually prepared by allowing benzaldehyde to react with anhydrous sodium acetate. The ensuing endothermic chemical reaction produces water and sodium cinnamate. The phenyl ester is phenyl cinnamate. If one considers the several radicals of benzyl cinnamate, one finds that it consists of (*a*) two phenyl radicals, which have no effect other than that of an astringent and disinfectant; (*b*) one di-methenyl radical, which has no known pharmacodynamic effect except, possibly, hemolysis, which is unwanted; (*c*) one methylene radical, and (*d*) one carbon dioxide radical, which certainly has no effect on the corneal opacities. If carbon dioxide were effective it would be easier for the patient to increase this gas in his body by slowing his respiration.

I have had no experience with this method of treatment. On the basis of pharmacologic considerations, I believe that at present there is little reason for employing this compound in ophthalmologic practice. Prior to clinical administration of the drug, further pharmacodynamic experimentation seems to be indicated.

DR. JACOB JACOBSON: I cannot understand why Dr. Castroviejo's results are so different from the results which were presented by the other speakers. He was, however, one of the judges of this method of treatment, and I shall not discuss his verdict.

Dr. Tusak, who admittedly has never used this drug, reasons from theoretical chemistry that it is harmful, but all those who have used it recognize, without exception, that it is absolutely harmless.

When reviewed objectively the results presented at this meeting are of both scientific and practical interest. From the scientific point of view, one sees how chronic inflammatory corneal lesions of diverse etiology regress under the influence of a chemical which necessarily acts through the blood stream, because it is not applied locally. The cornea offers the additional privilege of studying this regression with the slit lamp. From the practical point of view, one sees how in patients with old chronic corneal opacities, refractory to all previous treatment, for the relief of which the therapeutic arsenal has nothing more to offer, this harmless, well tolerated simple method of treatment is able to improve vision from 10/200 or 20/200 to 20/30, or from an ability to count fingers to vision of 20/100; and even in those with only perception of hand movements or of light, it is able to give vision of 5/200 or better.

An improvement in vision of 5/200 is not so important for patients with good eyes; but for patients with only perception of hand movements and of light it means new life. It is interesting to note that two patients who have been coming to the clinic accompanied by guides for five or six years are so improved after three courses of injections that they now come alone.

SURGICAL TREATMENT OF RETINAL DETACHMENT

SANFORD R. GIFFORD, M.D.
CHICAGO

It is fitting that in this year, following the death of Gonin, which occurred on June 10, 1935, ophthalmologists should remember their debt to him for what is undoubtedly the greatest advance made in clinical ophthalmology during the past twenty years. In 1904 he advanced the theory that the tears or holes which had previously been observed in detached retinas by de Wecker, von Graefe, Leber and others were the cause of retinal detachment. In 1919 he first reported cases in which he had operated with the cautery to close such tears and in which a reattachment of the retina had occurred. By 1931 [1] he had collected 300 cases, in 221 of which operation had been performed by his method. In 118, or 53 per cent, of these cases a reattachment was obtained which was maintained during the time in which the patient was observed. Only 75 of the patients were observed in what Gonin considered the favorable period—within the first three months—and in this group the incidence of reattachments was reported to be 66 per cent. The idea of inserting a red-hot cautery into the human eye was repugnant to most ophthalmologists, and it was not until about 1927 that a respectable number of Europeans felt inclined to follow the lead of this professor in a small Swiss university. In 1929, however, Gonin's report before the International Congress in Amsterdam, Netherlands, which I had the pleasure of hearing, was the outstanding event of the congress, and before long ophthalmologists of the world were beating a path to his door.

Gonin's methods have been improved on in various ways. With the development of some quite different procedures more cases are found suitable for operation, and results are better than those which most ophthalmologists were able to obtain with his original technic. His idea of how the hole is closed has been modified. In discussing Dr. Albert Brown's paper in 1930, I [2] suggested:

> . . . cauterization of the vitreous and under surface of the retina [and I should have said the choroid] in the region of the hole causes the production of an

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From the Department of Ophthalmology, Northwestern University Medical School.

1. Gonin, J.: Ann. d'ocul. **168**:689, 1931; Brit. J. Ophth. **17**:726, 1933.
2. Gifford, S. R.: Tr. Sect. Ophth., A. M. A., 1930, p. 242.

exudate to which the retina adheres when the escape of the retinal fluid brings the two surfaces in contact. The hole may not close but simply be cemented hermetically to the underlying exudate.

The same idea naturally occurred to others, and the process was described by Fisher, of London, as "seclusion of the hole" and by Arruga as "adhesive choroiditis." In spite of these important modifications, it is due to Gonin's persistent exposition of his theory and especially to his courage in following it in surgical practice that retinal detachment is now known to be a surgical condition amenable to cure in a large proportion of cases if attacked in an early stage.

MODIFICATIONS OF THE METHOD OF GONIN

The modifications in Gonin's method were made necessary by the number of cases in which the hole was too large to be closed by one cautery puncture, especially in the commonly occurring cases in which a disinsertion of a large portion of the retina from the ora serrata had occurred, and in those in which multiple holes were present. Gonin recognized these limitations of his method, and I remember his picturesque words when I asked him what success he had in cases in which large holes were present. *"C'est plus facile de tirer sur un elephant que sur un lapin,"* he said, *"mais pas si facile de le tuer."* (It is easier to shoot an elephant than a rabbit, but not as easy to kill him.) Space is not available to describe the various methods devised to overcome these difficulties—the chemical cauterization employed by Guist and its modification by Lindner, the flat coagulation of the sclera by Larssen, and the use of carbon dioxide snow by Bietti.

It will be sufficient if I describe in more detail the method of microcoagulation with which I have had most experience and which is now employed by most ophthalmologists who perform operations for retinal detachment. I shall add a few words on two other methods which may offer advantages in certain cases. Weve,[3] of Amsterdam, Netherlands, first employed microcoagulation in certain cases, using a fine needle as the active electrode; this needle was inserted just through the sclera and choroid with a current of 50 milliamperes, the coagulation being repeated until the carefully localized hole was entirely surrounded by areas of coagulation. By this method the escape of fluid through the numerous minute openings allowed the eye to become rapidly soft. To meet this difficulty, Šafář,[4] of Vienna, Austria, devised a set of short pins with buttons, both single and multiple, which were inserted, treated with the proper current and left in until the operation was completed, when all were removed and the fluid was allowed to escape. Weve also later employed similar pins, but the use of the pins which remain in

3. Weve, H.: Ann. d'ocul. **171**:1, 1934.

4. Šafář, K.: Ztschr. f. Augenh. **83**:189, 1934.

during the operation is usually referred to as the Šafář method. American ophthalmologists are more familiar with the pins devised by Walker.[5] These accomplish the same effect as that achieved by the pins used in the method of Šafář, namely, coagulation without loss of fluid, but they have certain advantages. They contain 8 per cent of platinum and iridium, and so can be sterilized and cleansed thoroughly in a flame. More important than this is the ingenious use of a hollow coil in which the handle of the electrode is set; the angle of the point makes them much easier to handle than the Šafář pins and—what is most important—easy to apply to the sclera far back on the globe. The later pins have the coil pressed to a triangular shape to fit a triangular center pin on the handle and are shorter than the original pins, so that there is less danger of producing holes in the retina. Walker has recently devised a number of multiple pins by the use of which the time of operation may be shortened somewhat. These introduce certain complicating conditions, however, such as unequal amounts of coagulation at the various points, difficulty of application and greater chance of dislodgment of the pins with movements of the eye, so that for the average operator the use of the single pins seems to me advisable. The Walker pins may be used with any form of diathermy apparatus which will take the special handle. Such an apparatus must be capable of accurate adjustment to give a current of low milliamperage, from 40 to 50 milliamperes. The apparatus devised by Walker for this purpose has proved quite efficient and is, besides, of relatively low cost.

The two more recent methods which must be mentioned are the use of diathermy with a pyrometric electrode, as devised by Coppez,[6] and the use of electrolysis, as employed by von Szily and Machemer[7] and by Vogt.[8] The latter was used long ago by Verhoeff, but without relation to the hole. The former method calls for the use of an ingenious electrode embodying in its tip the poles of a thermocouple circuit by which the actual amount of heat at the tip is recorded. The tip must necessarily be larger than a needle, and hence is applied to the sclera or, according to Meesman's[9] modification, to the outer surface of the choroid through a small scleral opening. Knapp,[10] after having had

5. Walker, C. B.: New Devices and a Modification for Diathermic Operation and Localization in Separation of the Retina, Arch. Ophth. **12**:970 (Dec.) 1934.

6. Coppez, L.: Arch. d'opht. **50**:598, 1933.

7. von Szily, A., and Machemer, H.: Klin. Monatsbl. f. Augenh. **93**:721, 1934. Machemer, H.: ibid. **93**:489, 1934.

8. Vogt, A.: Ztschr. f. Augenh. **85**:2, 1934; Arch. f. Ophth. **133**:26, 1934.

9. Meesman: Technic of Diathermocoagulation and Use of Pyrometric Electrodes in Detachment, Arch. Ophth. **13**:710 (April) 1935.

10. Knapp, A.: Present Methods of Operating for Detachment of the Retina in Europe, Arch. Ophth. **13**:693 (April) 1935.

some experience with this method, recommended it highly and stated that he had obtained excellent results with it. It gets away, however, from the principle of coagulating the inner surface of the choroid as near as possible to the hole without unnecessary damage to the sclera and requires a complicated set-up which might be difficult to keep in order. Practically the desired amount of coagulation can be delivered accurately by the more simple diathermy machines with a current of 45 milliamperes for two or three seconds, and the immediate results can be verified with the ophthalmoscope.

Electrolysis was thought of by a number of ophthalmologists, but its possibilities were first systematically investigated by von Szily and Machemer. Good results have also been reported by Vogt; these were of especial interest in several cases in which operation by other methods had been without result. In this method a current of low milliamperage (from one-half to 10 milliamperes) is employed through a fine needle. The effect depends on the chemical action of the active ions generated in the fluids at the negative or positive poles, with only a moderate elevation of temperature. Hence the results are comparable to those obtained with the methods of Guist and Linder, but the application may be made more accurately and the amount of effect can be graduated; moreover, the reaction occurs slowly and with a minimum of damage to the tissues. The work of von Szily and Machemer shows that more coagulation is produced around the positive pole (anode) by the alkaline ions, and this pole is used as the active electrode or else as a special apparatus in which both poles are applied to the sclera or just through it. In the hands of von Szily, Vogt and a few others, electrolysis has become the operation of choice in all cases of retinal detachment. Walker has used it in a number of cases, and he expressed the belief that it is especially suitable in cases in which many small retinal holes are present. No one, however, has as yet published a series of results with this method which compares with those reported by Šafář, Weve and others as obtained by coagulation with the short pins. It remains to be seen whether certain types of detachment will prove more amenable to electrolysis and whether it will even be found preferable to the diathermy methods in most cases.

OBSERVATIONS ON A SERIES OF CASES

My own experience began in 1929 with the Gonin method, with which a few excellent results were obtained in a limited number of cases. The best results were obtained in the first case in which I performed an operation by this method. The case was that of a young man in whom aphakia had developed after a traumatic cataract many years before; he was seen within a week after the detachment occurred

and operated on at once. The fairly large horseshoe-shaped hole was closed by one application of the cautery, the operation resulting in recovery of an excellent field and 20/20 vision, which has been retained for at least three years. The number of cases in which this method is unsuitable because of large or multiple holes led me to try the method of Guist. This method proved feasible but had many drawbacks. It was difficult to make the necessary number of trephine openings without perforating the choroid when the eye became so soft that it was necessary to discontinue the operation. Reactions were severe, and a few hemorrhages in the vitreous occurred after the procedure. In one eye the detachment became much worse after a very conservative application of the Guist procedure, and after an ill advised attempt to inject fluid into the vitreous after removing subretinal fluid the eye was lost. This was the only loss of an eye in my series. In one case of recurrence following two operations by the method of Gonin an excellent result was obtained by the method of Guist, vision of 20/50 persisting for one and a half years. Then, after a severe accident a third recurrence took place. The number of patients (17) operated on by the methods of Gonin and Guist is so small that a detailed report of results would be of no statistical importance.

The Šafář method with Walker's pins has been employed exclusively for the past three years, and a review of this material may serve to bring out some points of practical interest. Only the cases in which operation was performed are included, a number of patients having been considered inoperable for various reasons. Chief among these was duration of the detachment, as good results become exceedingly infrequent when detachment has existed longer than six months. In 1 case, in which there was a disinsertion of the whole upper half of the retina, the retina being folded over so as to hang down almost to the lower visible periphery, operation was considered inadvisable. In a second case, in which a similar condition existed in the only eye, operation was performed without result. (The latter case is included in the series.) Old age was in many cases considered a contraindication for operation, and in most patients over 60 who had a good second eye, operation was not advised. Reasons for this will be discussed later. In one woman aged 62 the detachment involved an eye which had always been amblyopic. Operation was not advised, although a small typical hole was present. This was fortunate, as six months later an acute attack of glaucoma occurred, and the diagnosis of intra-ocular neoplasm then made proved to be correct on enucleation. I mention this case because the presence of a hole had always been considered as an indication of typical idiopathic detachment and as evidence against a tumor. Transillumination at the first examination of this patient had given negative results. A few cases in which a previous operation of another type

was performed and was followed by recurrence and in which electrocoagulation was resorted to later are not included in this series.

Preoperative Treatment and Anesthesia and Operative Procedure.—The technic of operation has been in general the same, the chief variations being in preoperative and postoperative treatment and in the number of pins employed. First of all, every attempt is made to find the retinal hole or holes, as it is about these that the operation should center. As Gonin has said, this often requires more time than the operation. He found holes in all but 3 per cent of the cases referred to him, and in a large number of these cases previous examiners had failed to find any hole. Most ophthalmologists can verify such experiences. In the present series of 32 eyes holes were found in all but 4. The finding of holes requires maximal dilation of the pupil, for which administration of epinephrine is often necessary, and enough experience to give one a mental image of all possible varieties of hole. While the large holes cannot be overlooked, small ones are often seen only as a red area against a paler pink background, usually with a distinct, but often with a barely perceptible, border. Then there are the larger areas in which the posterior layers of the retina have retracted from the ora serrata, leaving a thin sievelike membrane of the nerve fiber layer in which the vessels run without interruption. Usually there are seen a number of small red spots in such an area, where the meshwork allows a view through the membrane, but these may be so small as to be invisible. Bartels [11] and Roggenkämper [12] have called attention to the importance of such areas, and in my experience they form the type most commonly missed. When one hole is located the search must be continued for other holes. Multiple holes were present in almost one third of the cases in this series. This is especially important in cases in which detachment has occurred some weeks before and when first seen involves only the lower half. Usually holes are found at the extreme lower periphery of the detached area, but it must not be considered that a hole in this location is necessarily the primary hole. Holes form secondarily in the detached retina, and in 6 cases of this series holes were found in the flat retina in the upper portion, either with or without holes in the detached lower portion. This is not surprising when one remembers that detachment most frequently begins in the upper part of the eye, the fluid later gravitating to the lower part. Failure to find the primary hole in the upper part in such cases and to attack it undoubtedly accounts for a number of operative failures, probably for the failure in case 3 in my series.

A good preoperative night is assured by giving the patient 1½ grains (0.097 Gm.) of phenobarbital or pentobarbital sodium at bed-

11. Bartels, M.: Klin. Monatsbl. f. Augenh. **91**:437, 1933.
12. Roggenkämper, W.: Klin. Monatsbl. f. Augenh. **94**:486, 1935.

time. Various narcotics have been tried in an attempt to control pain while avoiding postoperative vomiting. The importance of this cannot be overemphasized, as the patient must be perfectly quiet for the first few days after operation. The occurrence of vomiting has apparently been responsible for some operative failures in cases in which every other factor was favorable (cases 7 and 32). Vomiting has occurred occasionally with every drug, and the postoperative pain is too severe to be tolerated by the average patient without any narcotic. The drug which has caused least vomiting in my experience is dilaudid, a derivative of opium. One thirty-second of a grain (0.002 Gm.) is given hypodermically a half-hour before operation, and the dose is repeated during the operation and once after it if necessary. Vomiting has occurred only twice after such medication, and it was slight in these cases. In a number of cases the hypodermic administration of soluble phenobarbital in doses large enough to keep the patient in a somnolent condition for from four to six hours after operation was effective, but on the whole results have been better with dilaudid.

Atropine sulfate is instilled for a number of days before, and on the morning of, the operation. Cocaine is not employed, as the cornea must be kept clear for examination of the fundus during the operation. Only 1 drop of a 2 per cent solution of butyn is instilled before scrubbing and irrigating the eye, and this is followed by deep injection of procaine hydrochloride. Inducing akinesia by the method of Van Lint is also part of the routine, as the patient must not squeeze the lids after the pins are removed.

A large conjunctival incision is made fairly far back in the region of the hole. It is nearly always necessary to resect a muscle to get the pins far enough back, and a double-armed loop of 000 chromic catgut is placed through the tendon before the forceps is released. It is remarkable how much the resection of the muscle eliminates the pain formerly noticed, when it was necessary to employ forced rotation of the eyes against the pull of a muscle. It is usually best to inject a few drops of a 4 per cent solution of procaine hydrochloride beneath the muscle to be resected before the conjunctiva is opened.

The hole is localized by direct ophthalmoscopic examination after the field is ready for the first pin. This is placed as near to the estimated location of the hole as possible, and it has been found practical to measure 11 mm. from the limbus to a point just back of the visible periphery, adding a millimeter to this in case of highly myopic eyes. The pins are introduced with a current of from 35 to 40 milliamperes, which is just enough to allow them to penetrate without notable pressure. Once in, the current is left on for a fairly rapid count of three; then the handle is removed gently without disturbing the pin. The location of the coagulation produced by the first pin is verified at

once by ophthalmoscopic examination and further pins are placed in relation to this, so as to surround the hole at intervals of from 1.5 to 2 mm. Frequent ophthalmoscopic control is necessary during the operation, and this requires that the cornea be kept moist with physiologic solution of sodium chloride. The small contact glass of Lindner has been employed, but it is difficult to keep in place and is unnecessary in most cases. A method of localization employed by Lindner is useful when peripheral holes are present. The assistant observes the hole with the pinhole diaphragm on the ophthalmoscope, which throws a fine beam of light on the overlying sclera. This can be seen by the operator in a darkened room and is marked by a probe dipped in saturated alcoholic solution of gentian violet. This is exceedingly accurate when it can be employed, but when the holes are some distance back it is difficult to see the light on the sclera without rotating the eye, and this rotation makes it impossible to see the hole.

Enough pins are introduced to surround the hole, and if multiple holes are present the area of each hole is treated in the aforementioned manner. When disinsertion is present a semicircle of pins is placed around the whole area, which often occupies a quadrant or more. Usually additional pins are placed 13 mm. from the limbus to the limits of the detached area, the intervals between these pins being greater than those about the hole, 3 mm. or more. The pins at the ends of the detached area are brought up to within 10 mm. of the limbus in accordance with Guist's idea of a barrage of the detached area to the ora serrata on each side. It is doubtful whether these are necessary, however, if a large enough area immediately about the hole is coagulated. In several cases in which a hole above was present in the upper part and the detachment in the lower part, no coagulation was done in the lower part, only a trephining to drain the subretinal fluid, the coagulation being limited to the region of the hole. Results were as good as in other cases in which a ring of pins was inserted in the lower part as well. The tendency is to use less pins than formerly, from sixteen to twenty usually being sufficient.

In cases of recent detachment in which there was much elevation a trephining has always been performed in the area of greatest detachment, as with the short pins sufficient fluid may not escape from the holes made by the pins alone. This is performed before the pins are withdrawn, when the normal tension is still maintained, and the use of the Green spring-driven trephine has proved exceedingly convenient, as it avoids appreciable pressure. Only the sclera is trephined, the choroid being then penetrated by a tear point dilator. The eye at once becomes soft, and the muscle and conjunctiva must be sutured with the minimum of manipulation to the globe.

Postoperative Treatment.—In postoperative treatment it still seems safest to insist on almost complete immobility of the head for the first four days. In cases of detachment of the upper half of the retina the foot of the bed is raised slightly for the first four days, while in cases of detachment of the lower half the back rest is kept raised 15 degrees or more. The first dressing is done after four days, but both eyes are kept closed, and the patient is kept in bed for two weeks. Then a small hole in the shield or hole glasses are allowed, and the patient usually can be taken home in from three to four weeks after operation. After from six to eight weeks the hole glasses are exchanged for a pair of lenses frosted except for central areas of from 4 to 6 mm., which are much less conspicuous.

Results of Treatment.—The table includes all the cases in which operation was performed by this method since it has been almost exclusively employed. As instances of positive results are included only the cases in which the retina was perfectly flat when the patient was last seen. In 2 cases results are classified as plus-minus because only a small area of detachment was left, which seemed fixed by surrounding adhesions, and a useful field had remained long enough to permit one to regard further progress of the detachment as unlikely. Cases in which a recurrence has been observed, even when it occurred after several months, are classed as failures unless later operations proved successful. In two patients with bilateral detachment both eyes were operated on, each eye being counted as 1 case.

It will be seen that of 33 eyes, in 16, or 48.5 per cent, the detachment was healed. This, with the 2 cases in which the results were considered plus-minus, makes the incidence of useful results 54.5 per cent. If only eyes observed during what Gonin called the favorable period, or within three months of the detachment, are considered, the percentage of good results naturally becomes higher. Of 24 eyes seen in the "favorable period" 13, or 54 per cent, healed; this, together with the 2 in which results were regarded as plus-minus, gives an incidence of useful results of 62.5 per cent.

It may be useful to consider the probable causes of failure in the 9 cases observed within the first three months in which results were negative. Case 10 was previously mentioned as one in which there was a complete disinsertion of the upper half of the retina from the ora serrata. The retina was folded down, inside out, so that the whole upper half of the choroid was visible. The eye was considered really inoperable, but an attempt was made since the other eye was aphakic and exhibited a detachment of three years' duration. In case 18, that of a man aged 60, detachment occurred soon after an operation for removal of a cataract; the media were cloudy, and the hole was not seen until

Observations in Cases of Detachment of the Retina

Case	Age	Duration of Detachment	Hole	Complicating Conditions	Result	Final Vision	Final Field	Postoperative Complications	Time Between Operation and Report	Comments
1	62	6 wk.	+	Other eye amblyopic.....	—	Hand movements	Worse	Hole made by pin did not close	2 mo.	Flat for 2 weeks after first operation; no result from second operation
2	53	3½ mo.	?	High myopia (—18); incipient cataract prevented clear view of hole	—	4/200	Same	Vomiting	4 mo.	
3	69	2 wk.	+	.....	—	Hand movements	Same	.....	4 mo.	Flat for 2 months with vision 20/200; recurrence
4	43	1 mo.	+	Large tear below macula; massive hemorrhage elevating macula 8 diopters	±	5/200	Improved	.....	3 mo.	All of retina flat except a small area just out from macula which was raised by old hemorrhage
5	41	3 wk.	+	Congenital ectopia lentis; fluid vitreous; other eye lost by detachment before	+	20/40	Almost normal	Secondary holes appeared	10 mo.	Recurrence with two new holes just below disk 2 months after first operation; healed by second operation
6	54	3 wk.	+	Other eye lost by detachment before	+	20/50	Fair	.....	9 mo.	
7	54	1 wk.	+	Patient unstable mentally....	—	Hand movements	Worse	Violent vomiting after first operation	14 mo.	Fluid remaining under retina after first operation though hole was closed; detachment in lower half occurred after second operation on upper half
8	48	3 wk.	+	.....	+	20/70 +2	Almost normal	Small pulmonary infarct 3 weeks after operation	7 mo.	Fine pigmentation in macula
9	48	1 yr.	+	Multiple holes; long duration	—	10/200	Poor	.....	7 mo.	Second operation refused
10	39	1 mo.	+	Retina turned down over nerve; whole upper part of choroid exposed	—	Light perception	.....	None	11 mo.	No hope of closing such a large hole
11	..	3 yr.	—	Aphakia; no hole seen.....	—	Light perception	.....	None	10 mo.	Retina fixed so it never became flat; shortening of sclera did not help
12	57	7 wk.	+	Aphakia	—	Hand movements	Poor	.....	2 yr.	Retina flat for 3 months with vision 20/200; recurrence
13	65	2 wk.	+	Other eye lost by detachment	±	5/200	Fair; central scotoma	Psychosis; patient sat up in bed and bumped head 24 hours after operation	5 mo.	Central scars causing scotoma; small area below raised but appearing fixed
14	56	2 wk.	—	.....	+	20/100	Contracted above for 3/220	.....	4 mo.	Flat for 2 months; then detachment of lower half probably due to leakage through a small area of operative scar; second operation refused
15	62	1 wk.	+	Other eye lost by detachment 5 years before	+	20/25	Normal for 3/1,000	.....	4 mo.	

16	21	1 wk.	+	Other eye lost in accident; aphakia and previous operations for cyst of the iris in remaining eye	+	20/30	Fair; some concentric contraction	.....	18 mo.	Secondary membrane prevented clear view of fundus
17	46	4 mo.	+	Disinsertion and hole near macula	+	20/100	Normal for 10/330	.....	11 mo.	Detachment below; hole above as well as disinsertion below; both closed at one operation
18	63	3 wk.	+	Recent aphakia; loss of other eye from detachment after operation for cataract; cloudy media prevented view of hole until after operation	—	Hand movements	Poor	.....	.....	
19	54	6 mo.	+	Opacities of the lens; many small tears	—	Light perception	Poor	Vitreous became cloudy; probably hemorrhage	8 mo.	Many fine holes in retina; fundus not visible all over on account of opacities of the lens
20	54	1 mo.	+	Detachment below; hole above	+	20/20	Good; slight contraction for 3/330	.....	8 mo.	Lower detached portion not coagulated but perforated by center pin
21	50	5 wk.	+	.....	—	Light perception	Poor	Secondary hole formed	4 mo.	
22	64	4 yr.	+	Long duration; age.....	—	5/200	Same	.....	6 mo.	Retina flat for 2 months; then recurrence; condition as before
23	52	2 mo.	?	.....	+	20/50	Good; some contraction for 5/330	.....	6 mo.	Hole not noted on record
24	41	2 mo.	+	Two very large disinsertions	+	7/200	Good	.....	1 yr.	Because of medicolegal reasons, no certainty that patient is giving correct vision; some degeneration in macula
25	22	6 mo.	+	Detachment below; hole above	+	20/25	Good	.....	2½ mo.	
26	..	6 mo.	+	Same	+	20/50	Good; scotoma	.....	3½ mo.	
27	54	2 mo.	+	.....	+	20/50	Almost normal	.....	11 mo.	Operation by Professor Lindner with Safár pins
28	55	2 mo.	+	.....	+	20/100	Normal for 3/220	.....	17 mo.	Region of hole in upper half coagulated; region of hole in lower half trephined
29	34	2 mo.	+	Detachment below; hole up and out	+	20/50	Normal for 3/220	Late vitreous hemorrhage	8 mo.	Poor vision due to myopic degeneration
30	14	2 yr.	+	Long duration; hole above; detachment below	—	Not known	.....	.....	18 mo.	Good result with vision 20/100 for 8 months; then hemorrhage
31	72	1 wk.	—	Aphakia and high degree of myopia	+	20/200	Good	Prolonged hiccup and cough	10 mo.	
32	52	3 wk.	+	Cough from old bronchiectasis	—	Hand movements	Poor	.....	5 mo.	Attempt to combine electrolysis and coagulation unsuccessful; secondary holes formed
33	29	2 mo.	+	.....	+	20/100	Good	.....	3 mo.	Flat for 2 months after first operation, then recurrence due to a small hole not closed; this hole closed by second operation

after operation. Case 12 was also one of aphakia, but good vision had been present for ten years after operation, and the media were clear. The retina remained flat for three months, and no cause for the recurrence could be found. Permission for a second operation was refused. Case 3 was that of a man 69 years old, and experience has led me to regard advanced age as an unfavorable condition. Aside from the necessity of moving such patients earlier than one would like, failure by other methods in a number of elderly patients in whom other conditions were favorable has left a distinct impression that the adhesion of the retina following coagulation is for some reason less firm than in younger patients. Fluidity of the vitreous may have something to do with this difference, but it is also noted that scar formation, as shown by the appearance of pigment in the scars, is apparently less active. In this patient only the lower half was coagulated, no hole being found in the upper half, and it seems possible that a hole in the upper part was overlooked.

In the other 5 cases conditions were not apparently unfavorable. In 2 of them, however (cases 32 and 21), secondary holes formed after operation, accounting for recurrence, while in case 32 the use of insufficient coagulation and an attempt to reenforce it by electrolysis at the first operation did not produce enough tissue reaction to close the first hole. This patient, also, hiccuped for two days after operation. In case 7 the patient vomited violently after the operation, and in this case apparently not enough fluid escaped from the pinholes to allow the retina to become replaced. By a second operation the upper half was sealed down, but a detachment of a large part of the lower half of the retina then occurred without any hole being detected. Case 1 was the only instance in which a hole made by one of the pins was apparently responsible for a recurrence. The retina was flat for several weeks, and then a recurrence began about this hole. A second operation was delayed by circumstances for six weeks; in that time a great part of the retina had become detached, and the second operation was without result. This patient was 62 years old, which again seems to indicate a faulty tissue reaction, since holes made by pins in younger patients have been seen to close as a result of the coagulation.

In case 14, that of a man aged 52 with a large disinsertion up and out, this was apparently closed by the first operation. An area at the lower end of the disinsertion remained red and was regarded with suspicion. The retina remained flat, and the field was excellent for three months; then a detachment in the lower half developed, being apparently due to leakage from the aforementioned area. A second operation was refused.

Of the 33 eyes reported on, 6 required a second operation, which was successful in only 2 cases. In several other cases a second operation was advised with some prospect of success but was refused.

Aside from the greater proportion of healed detachments in the eyes operated on early, the table shows that the visual results in the healed eyes were better when operation was performed within the first three to four weeks, vision of 20/50, 20/40, 20/30 and even 20/20 being obtained in most of these cases, while in eyes operated on later vision seldom amounted to more than from 20/70 to 20/200. It may be said that when the macular region has been detached for more than a few days, and perhaps only a few hours, central vision will always be poor. There were also cases in which the coagulation itself had to be considered responsible for poor central vision, as the reaction spreads to some distance from where the pins are applied. This must be considered the lesser evil, however, provided the hole is closed and the detachment itself healed. One spares the macular region whenever possible, but it cannot be spared when holes are in its proximity. A glance at the table or at the results in any other series of cases proves the immense importance of performing the operation as early as possible. Engelking [13] discussed the question whether it is a *Kunstfehler,* or professional negligence, not to advise operation at an early stage in cases of retinal detachment, and I believe that one must agree with him that in most cases it is.

Aphakia is usually considered an exceedingly unfavorable complicating condition. Šafář obtained healing in only 1 of 7 aphakic eyes. A distinction must be made, however, between detachment occurring immediately after operation for cataract with loss of vitreous, in which the media are cloudy and the eye is always soft, and detachment occurring some time after extraction of the lens, with clear media. In the former condition good results are practically never obtained, while in the latter an appreciable number of good results are recorded. In this series there were 4 cases of aphakia and 1 of dislocation of the lens; in 3 of these good results were obtained. To this must be added the 1 case in which an excellent result followed ignipuncture, as already described.

In this series good results were obtained in 4 cases in which no useful vision existed in the other eye, while in 1 other case the result was classified as plus-minus. Since in nearly every case the other eye had been lost by detachment, this gives some idea of the importance of the operation. The amount of vision obtained in these cases was 20/50, 20/25, 20/30, 20/40 and 5/200, respectively. In a case in which the involvement was bilateral vision of 20/25 and 20/50 was obtained.

13. Engelking: Klin. Monatsbl. f. Augenh. **91**:289, 1933.

It seems important to emphasize again the frequency with which a hole in the upper half causes detachment which when seen by the surgeon is confined to the lower half of the retina. This was undoubtedly true in 6 eyes of this series (cases 17, 20, 29, 30, 25 and 26) and was probably true also in case 3. Hence it is imperative to look for a hole in the upper half in cases of detachment of the lower half of the retina, even if holes are present in the lower half also. Results in these cases lead one to agree with the statement of Veil and Dollfus,[14] "It is better to obliterate a punctate hole by one cauterization well placed than to produce, without thought of tears, a large area of adhesive choroiditis."

Results in this relatively small series, while not as good as those reported by Weve and Šafář, agree fairly well with those in most other series, such as those of Veil and Dollfus, Knapp, Walker, and Dunnington and MacNie. They indicate what results should be in an average series. They can probably be improved by increased experience and especially by an increase in the general knowledge that detachment is a surgical condition and should be operated on at the earliest possible moment.

14. Veil, P., and Dollfus, M. A.: Arch. d'opht. **52**:781, 1935.

CERTAIN ASPECTS OF THE INTRACAPSULAR EXTRACTION OF CATARACT BY FORCEPS

INDICATIONS AND TECHNIC

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Though extraction of the cataract in its capsule is the ideal operation, the procedure is more difficult and the danger of prolapse of the vitreous is greater than in the extracapsular procedure, as the protection of the posterior capsule is lost. Notwithstanding, this operation is being performed in all parts of the world in steadily increasing numbers of cases, and progress is being made in studying its technic and combating the difficulties. The writings of Elschnig have done much to popularize the operation, especially in Europe.

In discussing the indications it is convenient to classify cataract into the following clinical types: mature, nuclear, nuclear and posterior cortical and intumescent (mother-of-pearl cortex) cataracts, phakosclerosis and hypermature, morgagnian and shrunken (disciform) cataracts. Of these, the nuclear and posterior cortical opacities are the most frequent immature cataracts.

In general the cataract is ready for operation when the anterior chamber is sufficiently deep and the patient can no longer read or do his work. It is not possible to tell in advance whether the intracapsular operation will succeed. There is no clinical evidence that the capsule is tense enough to permit traction, and when it is grasped by the forceps there is nothing to indicate the degree of capsular or zonular resistance. Success in grasping with the forceps depends on the state of the capsule, which may be thickened, of average size or thin and tense; in the last case the forceps slips off or the capsule ruptures. The subluxation depends on the state of the zonule, which generally varies with the age of the patient and with the condition of the eye. According to Redslob, in intracapsular extraction the zonular fibers are torn at the level of the lens, and it is doubtful whether the ciliary epithelium is injured where the fibers arise. It is also of interest to note that the capsule of the lens is lightly adherent to the hyaloid membrane in the patellar fossa. It is generally accepted that the possibility of successful intracapsular extraction increases with the age of the cataract.

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While certain cataracts dislocate more easily than others, one cannot be absolutely sure of the success of the maneuver and hence must always consider the possibility of the capsule's tearing during an extracapsular operation. I suggested the use of the Kalt forceps for intracapsular cataract and particularly in the case of the nuclear opacity with a clear cortex.

Many varieties of forceps have been devised for the intracapsular operation. I suggested the use of the Kalt forceps for intracapsular extraction in 1910 and have found it to be an excellent instrument, provided it is well made. This means that the central edges must be blunt and meet uniformly along the entire length of the cup and not only at the tip. Kalt originally recommended this forceps to remove a large piece of the anterior capsule in the extracapsular operation. The new instrument of Arruga is excellent and often permits a firmer grip on the capsule. The forceps recently devised by Blaskovics and by Imre are good, and as they grasp a smaller surface they take better hold of a thin and tense capsule. Another style of forceps was recommended by Henry Smith. This has a small flange posterior to the bend of each jaw. Smith likes the double cross-legged type because it maintains its grip of the capsule automatically. Sinclair uses the same type of forceps. The blades of the forceps close vertically in all these models; traction is exerted laterally and not from below, as would be more desirable. A satisfactory forceps with blades that close horizontally has not been devised.

In regard to the indications for intracapsular extraction, Blaskovics has stated [1] that the senile cataract, with the exception of the tumescent, brunescent and fluidified varieties, can be operated on in any stage. With the exception of the first type, in cases of which it is better to wait until the swelling has gone down before performing this operation, these should be extracted extracapsularly. This investigator has sometimes found it desirable in these cases after extracapsular extraction to remove the capsule with the Horváth capsule extractor. Elschnig [2] found that intracapsular extraction is not successful in cases of tumescent cataract, while it is most successful in cases of immature nuclear cataract and in those of posterior cortical cataract. This author [3] listed the indications for intracapsular extraction as follows: immature, nuclear or cortical cataract; senile nuclear cataract; mature cataract; hypermature cataract with a large, brown nucleus (the anterior cortex having been absorbed), and cataract brunescens. He listed as contraindications

1. Personal communication to the author.
2. Elschnig, A.: Ztschr. f. Augenh. **26**:136, 1893.
3. Elschnig, A.: Die intrakapsulare Starextraktion, Berlin, Julius Springer, 1932, p. 50.

tumescent cataract and morgagnian cataract. According to Kubik,[4] the intracapsular operation is contraindicated in cases of intumescent cataract with a silky luster, in those of hypermature cataract with a large nucleus and in those of hypermature cataract with a fluidified cortex. Kadlický [5] found that in cases of mature cataract the capsule can always be seized; subluxation succeeds in 88 per cent of the cases of phakosclerosis, in 68 per cent of those of hypermature cataract, in 68 per cent of those of mature cataract and in 27 per cent of those of intumescent cataract. Holland [6] wrote that the intracapsular method is contraindicated in cases of congenital or juvenile cataract in persons up to 36 years of age, in cases of senile cataract in exophthalmic eyes, in plethoric patients, in cases in which the suspensory fibers are unduly resistant, in cases of glaucomatous cataract and in those of traumatic cataract. According to Wright,[7] the intracapsular operation is not indicated in cases of morgagnian cataract, immature cataract with a resisting zonule and cataract with a thin capsule. According to Arruga,[8] the intracapsular operation should not be attempted in cases of congenital cataract; in those of traumatic or membranous cataract; in young persons; in cases of intumescent cataract, in which one cannot grasp the cataract with the forceps if the swelling is pronounced, and in those of over-ripe cataract. Saint-Martin, in his excellent report entitled "L'extraction capsulo-lenticulaire de la cataracte," which was read before the French Ophthalmological Society, in 1935, stated that every one is agreed that the types of cataract most suitable for intracapsular extraction are the incomplete nuclear or cortical opacities, phakosclerosis and the mature cataracts. Less suitable are the intumescent cataracts, in which the capsule is tense and slippery; the hypermature cataracts; cataracts with a large nucleus and a fragile capsule; shrunken cataracts, and cataracts in perons with tetany.

It will have been noticed that there is a general unanimity in the selection of the cataracts that are suitable for this operation, with which my experience leads me to agree. The recent improved methods of anesthesia and other aids have greatly reduced the list of contraindications, especially on the part of the noncooperative patient. In general, it can be said that the intracapsular operation may be attempted, with due caution, in every case of senile cataract. Its trial may lead to dislocation of the lens, with rupture of the hyaloid membrane and prolapse of vitreous (which, fortunately, is an unusual complication) or to rupture of the capsule, in which case the eye is subject to the complication

4. Kubik, J.: Zentralbl. f. d. ges. Ophth. **32**:444, 1935.
5. Kadlický, R.: Bratisl. lekár. listy **11**:390, 1931.
6. Holland, H. T.: Arch. Ophth. **53**:155, 1924.
7. Wright, R. E.: Am. J. Ophth. **16**:230, 1933.
8. Arruga, M. H.: Bull. et mém. Soc. franç. d'opht. **48**:222, 1935.

of retained cortex, especially if the cataract is an immature one. The question whether fluid vitreous is a contraindication is often raised. I am not convinced that this is a contraindication, if it is assumed that its presence can always be recognized beforehand. I have found that the cataract in glaucomatous eyes dislocates readily. In Elschnig's experience, the zonule in myopes is weak, and the operation is facilitated thereby. Complicated cataracts have a weak zonule; in cases of this type intracapsular extraction is easy, and a postoperative reaction from retained cortex is avoided. Persons with high myopia have weak zonules, while persons with the hypermature type of cataract have strong zonules.

The preliminary steps of the intracapsular operation are practically standardized; this is due to the popularization of the technic in Elschnig's writings. The administration of sedatives, the induction of akinesia, suture of the superior rectus muscle, deep intra-ocular injection, section with a conjunctival flap or with Kuhnt's conjunctival keratoplasty, conjunctival suture and iridectomy, complete or partial, with slight unimportant variations, are practiced by all operators.

The application of the forceps and the following steps require a more detailed description. Henry Smith [9] stated that the first requisite in intracapsular extraction is to dislocate the lens and to detach it from the suspensory ligament; this can be done only if the lens is made to swing about a transverse axis. The capsule of the lens is grasped at points that vary according to different operators, Verhoeff beginning above at the upper extremity, Török in the upper half of the anterior surface and Elschnig, Arruga, Blaskovics and I in the lower half of the anterior surface. It stands to reason that with the two first-mentioned procedures the upper attachments of the lens are separated first, while with the last-mentioned procedure the lowest attachments are torn first. With the forceps gripping the capsule firmly, counter-pressure is exerted below, and the lens is moved in various directions until subluxation has taken place. This is recognized by the zonula's giving way at one point; then the corresponding margin of the lens appears in the pupillary space. Henry Smith has suggested the following technic with the aid of his special capsule forceps, which has previously been described: The capsule is grasped by the forceps in its lower part. Then by tilting the shaft back the flanges are brought in contact with the posterior lip of the incision, restraining the upper pole of the lens, while the lower pole is levered forward.

The next step is the expression of the cataract, which is made either by traction or by pressure. With the former procedure the capsule

9. Smith, Henry: The Treatment of Cataract and Some Other Common Ocular Affections, London, Butterworth & Co., Ltd., 1928, p. 160.

forceps retains its hold on the capsule, and the lens is drawn out, with pressure applied to the lower part of the cornea. If the capsule is grasped above the horizontal level, the cataract will come out head-on; if it is grasped below, the lens must tumble.

The extensive experience of Henry Smith has shown that by tumbling the intracapsular extraction is freed to a great extent of the danger of loss of vitreous, as the place of greatest liability to prolapse of vitreous on the application of pressure to the eyeball is the site of the incision, and this area is protected by an intact suspensory ligament when the maneuver of tumbling is followed. The accomplishment of the maneuver of tumbling can be obtained only by grasping the capsule as low down as possible so that the lowest zonular fibers are torn. After subluxation, with the forceps either remaining in contact or released, pressure at the lower corneal margin causes the lens to tumble. I have always advocated grasping of the capsule in its lower third, not only because thereby the lens is made to tumble but also because if the capsule ruptures the opening will be in the pupillary area. Verhoeff [10] exerts pressure on the lower part of the cornea, which causes the upper part of the lens to tilt forward; the upper margin is then grasped with his forceps, and the lens is removed by traction from above, combined with pressure below. Loss of vitreous is prevented by keeping the lens in contact with the posterior lip of the wound while exerting traction.

After subluxation of the cataract either the forceps continues to grip the capsule or it is released. In the former case much greater traction is exerted on the capsule of the lens, especially in a circumscribed area, and when the lens tumbles the forceps must be turned to allow for the delivery of the lens. If the lens is not moldable the capsule is likely to rupture. To avoid this I have always relaxed the hold of the forceps as soon as the subluxation has taken place and found, provided the section is large enough, that the lens tumbles readily and is extracted easily by the Smith technic. This consists in applying the tip of the large Smith hook to the lower limbus, pushing straight back and, with counter-pressure above, moving the point of the hook along the arc wherever there seems to be some obstruction. Thus the cornea is folded up under the appearing lens, the pressure changing to an upward direction and away from the vitreous, and the lens, which is adherent only at its upper extremity, can then be swept away from its final attachment by the curved surface of the hook. If the eyeball softens as a result of the retro-ocular injection, it is naturally more difficult to extract the lens by pressure than by traction.

While most operators have recognized the value of the maneuver of tumbling and therefore grasp the lens as far down as possible, the

10. Verhoeff, F. H.: Tr. Am. Ophth. Soc. **25**:54, 1927.

method of extraction by traction has been the one generally practiced. I do not know why this is so, unless it is because it looks easier or because the Smith technic is not understood. My objection to traction is based on the far greater number of torn capsules, and, with some operators, the greater loss of vitreous than occur with tumbling. While a torn capsule may be separately extracted after the delivery of the nucleus and cortex if the rupture takes place at the end of the extraction, this procedure is much more difficult if the hyaloid membrane is ruptured at the same time and there is prolapse of vitreous. It is self-evident that the capsule should be gotten rid of, if possible, and in any case it should not be permitted to remain caught in the wound.

If the cataract does not seem to be dislocated it can be grasped again, or the area of dislocation may be enlarged. The freer the lens is, the less pressure is required to cause the lens to tumble. The amount of capsule grasped by the forceps should vary; as a rule, the smaller the area grasped the more likely the capsule is to burst. The closing of the blades must not be greater than just enough to hold the capsule; too firm pressure tears the capsule. If the capsule of the lens is tense and difficult to seize, a forceps with a smaller grasping surface (Imre) may serve best. In cases of morgagnian cataract the blades of the forceps have to be opened wide to embrace nearly the entire circumference of the lens before a hold is obtained; then, of course, the soft contents are under particular pressure, and the capsule is likely to burst.

It is necessary to know the amount of traction that the eye will stand, as the zonule may be very firm or too elastic. The reaction from too great traction depends on the particular eye and the patient's general condition. It is best to be conservative; if the zonular fibers do not rupture after a reasonable amount of traction, the attempt at intracapsular extraction should be abandoned and the extracapsular procedure followed.

CHEMISTRY OF THE RETINA

III. AUTOLYSIS

ARLINGTON C. KRAUSE, M.D.

CHICAGO

Autolysis is one of the many pathologic processes which may occur in the retina. It may be defined as the self-digestion of the tissue which results from the action of enzymes that are naturally present in the tissue. Autolysis is inhibited in alkaline tissue, but in acid tissue its rate is determined by the hydrogen ion concentration of the tissue. If the autolytic changes become irreversible, the end-result is atrophy.

The term autolysis does not include the effect which is produced on the retina by the action of enzymes from nonretinal tissue, leukocytes, bacteria or fluids entering the retinal tissue. The effect on the tissue resulting from the action of extracellular enzymes is called heterolysis.

The autolysis of the retina has been only incompletely studied. Galante [1] followed the rate of formation of amino-acid during proteolysis of the tissues of the eye by means of the formaldehyde titration method. He observed that the rate of proteolysis of retina was more rapid than that of other tissues of the eye. Sala [2] studied the pathologic changes of the retina placed in sterile saline solutions. He observed that the earliest alteration was swelling of the tissue, particularly in the nerve fiber and in the ganglionic layer, and he found that lipids were liberated from the lipid proteins of the cytoplasm.

Similar processes occur in other nerve tissues during autolytic degeneration. In the brain [3] the rate and extent of proteolysis is dependent on the hydrogen ion concentration. In alkaline or neutral mediums the autolysis is inhibited and is increased with the acidity. The amount of acid required for autolysis of brain is relatively small as compared with that required for other tissues. In nerve tracts there is a temporary increase of hydration followed by a decrease of phospho-

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1. Galante, E.: Azione degli strati epiteliali anteriori e posteriori della cornea sul decorso dell' autolisi del tessuto proprio corneale, Boll. d. Soc. ital. di biol. sper. **2**:337, 1921.

2. Sala, G.: Alterazioni della retina da autolisi, Boll. d'ocul. **12**:161, 1933.

3. Gibson, C. A.; Umbreit, F., and Bradley, H. C.: Studies of Autolysis: VII. Autolysis of Brain, J. Biol. Chem. **47**:333, 1921.

lipid,[4] and liberation of phosphate,[4b] glycerin [4b] and choline.[4a] In the spinal cord, free amino-acids are formed [5] and the cholesterol, fatty acid and fat content is altered.[6]

The present report on autolysis of the retina is one of a series of articles on the chemistry of the retina.[7]

METHOD

From freshly slaughtered steers from seventy-five to one hundred eyes were removed, and the retinas were carefully dissected. The materials were handled as aseptically as possible. The retinal tissue consisted of neuro-epithelium and weighed from 52 to 65 Gm. The tissue was ground in a mortar, suspended in water and diluted to a liter. The water had been previously boiled, cooled and saturated with toluene. The p_H was adjusted with acetic acid and was controlled colorimetrically.

A 25 cc. sample was withdrawn, pipetted into a tared weighing bottle and dried at 100 C. to a constant weight. The resulting weight was recorded as weight of total solids.

Two 25 cc. samples were taken for the duplicate determination of soluble and of insoluble substances. The insoluble substance was washed consecutively with two washings each of 2, 5 and 10 per cent solutions of sodium chloride. The residue was then washed with water until it was free from chloride ions. It was then extracted with hot alcohol and with ether and dried and weighed. The weight was recorded as weight of insoluble protein. The alcohol and ether extracts were evaporated to dryness in a tared weighing bottle. The weight of the residue was recorded as weight of lipids of the insoluble substance.

The extracts soluble in water and saline solution were combined, acidified with acetic acid to p_H 6 and coagulated with heat. The coagulated mass was removed by centrifugation, washed with water and extracted with hot alcohol and with ether. The dried substances extracted with alcohol and ether were weighed, and the weight was recorded as weight of soluble protein. The alcohol and ether extracts were evaporated to dryness and weighed. The weight was recorded as weight of lipids of the soluble substance.

The cholesterol, nitrogen and phosphate contents of the lipids were then determined. The cholesterol content was estimated colorimetrically according to a

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4. (*a*) Mott, F. W., and Halliburton, W. D.: The Chemistry of Nerve Degeneration, Proc. Roy. Soc., London, s.B **68**:149, 1901. Halliburton, W. D.: Die Biochemie der peripheren Nerven, Ergebn. d. Physiol. **4**:23, 1904. (*b*) May, R. M.: The Water and the Phosphorus Combinations of Degenerating Nerves, Proc. Soc. Exper. Biol. & Med. **28**:49, 1930.

5. Marinesco, G.: Le rôle des ferments hydrolytiques et du déséquilibre acido-basique dans le mécanisme des maladies familiales et abiotrophiques; leur rapport avec l'autolyse, Bull. Soc. roumaine de neurol. **2**:151, 1925.

6. Sugimoto, S.: Beiträge zur experimentellen Untersuchung über die lipoiden Abbauprodukte des Nervengewebes: I. Experimentelle Untersuchung über die lipoiden Abbauprodukte bei der sekundären Faserdegeneration des Rückenmarks, Mitt. d. med. Gesellsch. zu Tokio **45**:288, 1931.

7. Krause, A. C.: The Chemistry of the Retina: II. Chemical Constitution, Am. J. Ophth. **19**:555, 1936; The Lipids of the Retina, Acta ophth. **12**:372, 1935.

modification of the Liebermann-Burchard test.[8] The nitrogen and the phosphorus content were determined by digesting a portion of the lipids with concentrated sulfuric acid and a 30 per cent solution of hydrogen peroxide. The digest was diluted to a convenient volume, and aliquot samples were used for the determination of nitrogen by nesslerization and of phosphorus by the method of Fiske and Subbarow.[9]

A 25 cc. portion of the retinal brei was heated to boiling, and the coagulated mass was removed by centrifugation. The clear watery supernatant fluid constituted the nonprotein water-soluble extract. A 20 cc. portion of this extract was evaporated to dryness and weighed. The weight was recorded as weight of soluble extractives. The coagulated mass was washed with water and then extracted with hot alcohol and with ether. The extracted residue was dried and weighed. The resulting weight was recorded as weight of total protein. The alcohol and ether extracts were evaporated to dryness and weighed. The weight was recorded as weight of total lipids.

A 50 cc. portion of the retinal brei was treated with 5 Gm. of solid tri-chloracetic acid and was then filtered as soon as possible. An aliquot sample of the filtrate was used for the determination of nitrogen according to the Kjeldahl-Gunning method. This nitrogen was reported as peptone and nonprotein nitrogen. Free phosphate was determined colorimetrically on an aliquot sample by the method of Fiske and Subbarow.[9]

The p_H of the retinal brei was checked colorimetrically at frequent intervals. The brei was incubated at a temperature of 37 C.

The choline was estimated according to the method of Lintzel and Monasterio.[10] The creatinine was determined colorimetrically.[11]

RESULTS

Tables 1 and 2 show the effect of hydrogen ion concentration on the autolysis of retinal tissue. The technical difficulties prevented the use of larger samples and finer comminution of the retina. The data are given in milligrams of substances in the sample of retina which has been undergoing autolysis for the given number of days. The first sample was taken a few hours after autolysis had begun.

According to the data in table 1, only a relatively slight chemical change occurs in the alkaline retina. The most marked change arises from hydrolysis of the soluble organic phosphates, creatine phosphate and adenosine tri-phosphate, into inorganic phosphate. A small amount of insoluble lipoprotein, probably visual purple, became soluble. This is to be expected, as visual purple breaks down in an alkaline dead retina on standing in aqueous mixtures exposed to light and air.

8. Sackett, G. E.: Modification of Bloor's Method for the Determination of Cholesterol in the Whole Blood or Blood Serum, J. Biol. Chem. **64**:203, 1925.

9. Fiske, C. H., and Subbarow, Y.: The Colorimetric Determination of Phosphorus, J. Biol. Chem. **66**:375, 1925.

10. Lintzel, W., and Monasterio, G.: Eine Methode zur Mikrobestimmung des Lecithins im Blute und Plasma, Biochem. Ztschr. **241**:273, 1931.

11. Folin, O., and Doisy, E. A.: Impure Picric Acid as a Source of Error in Creatine and Creatinine Determinations, J. Biol. Chem. **28**:349, 1917.

If the alkaline digest is made acid, a rapid chemical change takes place, as may be seen by the data in tables 1 and 2. The tissue swells. The total insoluble lipoprotein fraction is increased by being hydrolyzed into lipid and amino-acids. The soluble lipoprotein is decreased rapidly

TABLE 1.—*Autolysis of Retina*

Day of autolysis	1		3		9		10		15	
p_H	7.6		7.5		7.4		6.5		6.5	
Sample number	1	2	3	4	5		6	7	8	9
	Mg.	Mg.	Mg.	Mg.	Mg.		Mg.	Mg.	Mg.	Mg.
Insoluble fraction										
Protein	10.6	8.6	8.6	9.0	5.4	p_H 7.6	45.0	51.2	51.8	53.0
Lipid	7.0	7.0	5.4	3.0	3.0	changed to	18.6	22.0	22.0	22.6
Cholesterol	0.8	....	....	0.7	0.4	p_H 6.5 at	2.4	....	1.8	....
Nitrogen	....	trace	trace	....	trace	end of	....	0.2	....	0.13
Phosphorus	....	0.2	0.16	....	....	9th day	....	0.3	....	0.5
Soluble fraction										
Protein	....	120.2	....	120.2	112.0	p_H 7.6	52.0	49.2	41.0	43.0
Lipid	....	31.0	26.0	25.4	24.6	changed to	12.0	12.2	10.4	8.4
Cholesterol	....	3.2	3.4	....	3.5	p_H 6.5 at	....	1.2	....	0.9
Nitrogen	....	0.44	0.30	....	0.31	end of	0.12	....	trace	....
Phosphorus	....	0.90	0.70	....	0.86	9th day	0.30	....	0.26	....
Water-soluble extract*	39.2	....	....	45.7	46.4	p_H 7.6	48.7	....	53.0	....
Nonprotein nitrogen	125.4	....	....	131.8	131.8	changed to	182.9	....	227.6	....
Phosphorus	51.3	....	....	72.9	90.6	p_H 6.5 at	93.1	....	99.4	....
Total heat-coagulable proteine	131.0	....	....	129.8	120.1	end of 9th day	117.8	....	110.4	....
Total lipids	38.4	....	....	34.2	36.8		29.2	....	....	....

* The quantity of nonprotein nitrogen and that of soluble phosphorus in the water-soluble extract were calculated in milligrams per hundred grams of wet retina.

TABLE 2.—*Autolysis of Retina at p_H 6.5*

Day of autolysis	1		3		10		38	
Sample number	1	2	3	4	5	6	7	8
	Mg.	Mg.	Mg.	Mg.	Mg.	Mg.	Mg.	Mg.
Insoluble fraction								
Protein	26.8	36.0	67.6	69.6	66.2	69.2	79.8	61.2
Lipid	18.0	21.0	26.6	29.2	29.6	29.8	27.2	25.4
Cholesterol	1.6	....	3.1	....	....	3.4	....	2.4
Nitrogen	....	0.16	0.2	....	....	0.20	....	....
Phosphorus	....	0.61	....	....	....	2.79	....	....
Soluble fraction								
Protein	83.2	74.2	....	23.2	8.0	8.4	5.0	5.2
Lipid	19.2	16.4	....	3.1	2.0	1.4	1.0	1.4
Cholesterol	1.8	....	....	0.2	....	0.4	....	....
Nitrogen	0.19	....	....	....	....	traces	....	....
Phosphorus	0.43	....	....	....	....	0.02	....	....
Water-soluble extract*	33.0	....	....	42.3	....	54.7	58.8	....
Nonprotein nitrogen	112.0	....	....	286.8	....	394.2	508.4	....
Phosphorus	42.0	....	....	92.0	....	114.0	133.2	....
Total heat-coagulable proteins	112.8	....	....	96.8	....	91.0	83.4	....
Total lipids	35.8	....	....	32.6	....	30.8	28.4	....

* The quantity of nonprotein nitrogen and that of soluble phosphorus in the water-soluble extract were calculated in milligrams per hundred grams of wet retina.

to a small proportion of the original fraction. The amount of cholesterol remains practically unchanged. Apparently the soluble lipid is chiefly phospholipid and sphingomyelin, for the choline in the water-soluble extracts increased from a trace on the first day to 88.6 mg. of choline

nitrogen, or about 30 per cent of the nonprotein nitrogen, on the third day of autolysis. A part of the phosphorus which was increased in the water-soluble extract is derived from phosphate of the phospholipid of the soluble lipoprotein. The total diminution of the amount of lipid arises from the splitting off of choline and phosphate from the phospholipid and sphingomyelin, the choline appearing in the nonprotein nitrogen fraction and the phosphate in the water-soluble extract. The initial value for creatinine—1.45 mg. per hundred grams of fresh retinal tissue—is increased to 2.95 mg. on the second day.

COMMENT

There is no doubt that the retina undergoes autolysis in a manner similar to that in which other tissues do. The retina as a part of the brain is well protected from autolysis resulting from general asphyxia and acidosis by the peculiar natural mechanism controlling the circulatory equilibrium in the internal carotid arteries. The respiratory center, through its sensitiveness to the hydrogen ion, carbon dioxide and oxygen content of the blood, and the carotid sinus, through its reaction to vascular pressure, tend to prevent any cerebral and retinal acidosis arising from systemic circulatory disturbances. Thus any condition which tends to produce cerebral acidosis and indirectly retinal acidosis causes a compensatory circulatory and respiratory response of the whole body. Acidosis of another organ, however, may have no effect on the circulation in the internal carotid artery. As long as the brain can take care of itself and of the retina as well under these conditions, autolysis is inhibited. On the other hand, in certain other general conditions which cannot be rapidly compensated by the brain, such as acute anoxia, the retina may also suffer autolytic damage.

Besides abnormal systemic conditions, local pathologic disturbances may destroy the natural hydrogen ion equilibrium of the retina, resulting in acidosis and later in atrophy. This result occurs after the retina or optic nerve is injured by trauma, toxins, prolonged inflammation, arrest of the circulation or any agent. If the injury is sufficient to prevent recovery, atrophy of the retina and optic nerve takes place. The only way atrophy of retinal or any tissue is known to occur as a physiologic process not influenced by bacteria, leukocytes and exudates is through autolysis.

The results of all degrees of retinal atrophy are well known pathologically. If the retina suffers total atrophy from autolysis, only a reticulum of the supporting framework of the nerve tissue and the solid strands of connective tissue which were blood vessels remain.

Autolysis is similar in many respects to the reverse process of formation of retinal tissue. Normally anabolism is in equilibrium with

catabolism. The enzymes present in the alkaline retina take part in its growth, metabolism and physiologic function. They perhaps exist as inactive zymogens and become activated when the proper occasion arises. In the injured, dying or dead tissue catabolism predominates. The tissue is no longer able to prevent the formation of acids in excess. The enzymes then continue to break up dextrose into lactic acid, oxidize metabolites to carbon dioxide and form other acid products. Thus the hydrogen ion concentration of the tissue is increased. The osmotically inactive protein anion (protein) is replaced by the osmotically active bicarbonate ion and other diffusible anions leading to an imbibition of water and to a dilution of the base content. As a result the retinal tissue is swollen. A part of the retinal translucency is lost. If the damage is slight, the process is still reversible, but if it is not, the process continues. The lipoprotein aggregates that are dispersed colloids break up into lipid and protein which are insoluble substances no longer peptized. The proteolytic enzymes begin to act. The primary proteases that have an optimal action in acid mediums hydrolyze the intracellular protein into smaller protein fragments. In turn, the secondary proteases that act in either alkaline or acid mediums hydrolyze the secondary proteins into polypeptides and amino-acids. Other enzymes split up the lipids into choline, phosphate derivatives, nitrogenous lipids and other substances. Nucleoproteins are broken down into protein and nucleic acids, which are later hydrolyzed into polypeptides, amino-acids, purines and phosphate. The creatine phosphate is split into creatine and phosphoric acid and the adenosine tri-phosphate into adenine and phosphoric acid. The creatine in the acid mediums is transformed partly into creatinine. The water-soluble extractives which were bound in the intracellular tissue are liberated and are diffused. As the autolytic process continues, the large molecules and molecular aggregates are made more and more soluble by being fragmented into substances that diffuse away. Thus the tissue shrinks. Since the supporting connective structure is not attacked by the autolytic enzymes, it remains as a residue. Some of the substances, such as adenosine tri-phosphate, which are liberated or formed by enzymatic action are chemotactic and may attract leukocytes. Methylguanidine,[12] which is present in minute amounts in normal retina, choline, which is split off from lecithin by lecithinase, and peptones, which are formed during hydrolysis of proteins, are definitely toxic. Some substances may produce hemolysis, and others may prevent the clotting of blood. It is well known that products from the lysis of tissues stimulate and cause glial proliferation.

12. Krause, A. C.: Unpublished data.

Heterolysis is frequently associated with autolysis. In this process, leukocytic chemotactic substances, leukocytes, exudates and bacteria take part in the lysis of the tissue.

Leukocytes play an important part in the heterolysis of the retina. The proteolytic enzymes of the polymorphonuclear leukocytes have their optimal action in alkaline mediums and those of mononuclear leukocytes in acid mediums. Leukocytic proteases not only hydrolyze the same proteins on which the autolytic proteases act but are able to hydrolyze proteins of foreign substance, such as catgut, and also the supporting tissue proteins not touched by the tissue proteases, such as the retinal connective tissue.

In relation to experimental autolysis of the retina it is interesting to note that Opie [13] asserts that animals with leukocytes possessing a small amount of protease, such as those of rabbits, usually do not produce a liquid pus, that is, heterolysis produced by enzymes of such leukocytes is minimal.

The serum takes a part in heterolysis of the retinal tissue. It contains a natural antibody which is found in the albumin fraction of the serum proteins and which inhibits proteolysis. Serum also does not favor autolysis or heterolysis by its alkaline action. In old exudates the inhibition is decreased, and then autolysis takes place. If the ratio of serum to leukocytes is high, lysis is inhibited, as in serous exudates. However, if the leukocytes are the predominating element, the natural inhibitor is overwhelmed, and autolysis and heterolysis may begin. At this point it is well to remember that lactic acid which is formed in pus increases autolysis and heterolysis, for the inhibiting action of alkaline serum on proteases is lost in acid mediums. The slow autolysis that frequently takes place after arrest of circulation, such as that caused by thrombi or emboli, may arise from the action of the inhibitors of the serum.

In an infected retina or adjacent tissue many bacteria produce lactic acid in the lytic process and liberate their proteolytic and other enzymes. Staphylococci have proteolytic enzymes which are more active than those of streptococci. They also form much lactic acid. Pus is especially formed by the bacteria which produce acid and which through their products attract leukocytes that die and liberate enzymes. Tubercle bacilli and their products of their injury to the retina are not as attractive to leukocytes as cocci, and thus they cause less lysis of the tissues. There is reason to believe that soaps of unsaturated fatty acid in the tubercles arrest the action of enzymes. However, when leukocytes enter the tubercle, the lysis quickly begins.

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13. Opie, E. L.: Intracellular Digestion: The Enzymes and Anti-Enzymes Concerned, Physiol. Rev. **2**:552, 1922.

The relation of phagocytosis to autolysis and heterolysis of the retina need not be discussed here.

SUMMARY

A study of the chemistry of retinal autolysis has been made. Much of the pathologic process of atrophy of the retina may be correlated with its chemistry. The effect of leukocytes, infection and cellular proliferation has been discussed in connection with heterolysis and particularly autolysis.

A part of the material was obtained through M. R. L. Fox. The technical procedures were performed with the aid of Mr. W. Tauber.

TREATMENT OF STRABISMUS

INFLUENCE OF ORTHOPTIC TRAINING ON RESULTS OF OPERATION

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Early in the fall of 1933, at the request of Dr. T. D. Allen, an orthoptic clinic was started at the Illinois Eye and Ear Infirmary, and I was placed in charge. During my two and one-half years of work in that department many problems concerning strabismus arose, but in this paper only the operative results will be discussed.

In order to explain some of the problems to be presented here and to stress the significance of some of the end-results, I shall give a brief description of the manner in which the ophthalmologic department functions. The department is divided into six services, with an attending physician at the head of each service and with a staff consisting of associate, adjunct and resident physicians. The orthoptic department is a separate and distinct unit, but, as originally organized by Dr. T. D. Allen, it has always remained a part of his service. The orthoptic clinic has complete control of all patients with strabismus admitted to Dr. Allen's service. No such control, however, is obtained over the patients admitted to the other services. The physicians in charge follow any line of treatment that they feel is indicated. In the orthoptic department a definite routine procedure is maintained. On admission to Dr. Allen's service each patient with strabismus is at once transferred to the orthoptic department. Here the routine procedure consists of first taking the complete history and then making an objective examination, which includes making a diagnosis, measuring the angle of deviation and the angle of kappa or gamma, determining the degree of visual acuity and noting the amount of motility and fixation. Refraction after the instillation of a mydriatic drug (generally atropine sulfate) is then ordered. After the patient has worn his new glasses for two weeks the eyes are again examined. Then follows a period of from three to six months of observation before orthoptic treatment or surgical intervention is considered. If amblyopia of any degree is present an attempt is made to correct it during this period of observation. An attempt is made to give every patient some orthoptic treatment, but if at the end of the period of observation the patient is definitely considered unsuitable for orthoptic treatment, operation is ordered. Orthoptic treatment is begun from five to ten days after operation.

From the records of the Illinois Eye and Ear Infirmary.

Presented before the Section on Ophthalmology at the Eighty-Seventh Annual Session of the American Medical Association, Kansas City, Mo., May 15, 1936.

Patients are selected for treatment according to a definite set of indications, as described in my recent paper entitled "Orthoptic Treatment of Strabismus." [1]

Because of the close cooperation between the orthoptic department and Dr. Allen's service, this careful management of patients with strabismus exists only in this service. The management of patients with squint in the other services follows no definite routine. A few patients are selected for orthoptic treatment and are referred to the orthoptic department, but most of the patients are operated on with little preoperative preparation. It is my opinion that the difference evidenced in the two groups of patients, as illustrated in table 2, can be explained by this lack of definite preoperative preparation.

Since the inception of this clinic, many patients have been referred to it by the various other services. Although few patients were sent to the clinic before operation, a number were referred after operation. The condition in many of these patients was considered unsatisfactory by the service which sent them. It has been the aim of the orthoptic department to try to improve the results. In many cases the angle was undercorrected; in some it was overcorrected. In many of these cases success was achieved in completing the correction.

As the correction of strabismus means bringing the eyes back as nearly to normal as possible, it is the contention of my colleagues and myself that the attainment of parallelism only does not finish the task. When undertaking the correction of strabismus the physician is obliged not only to eliminate the deviation with treatment or surgical intervention but to eliminate amblyopia, if present, and to develop fusion. Then only, and not until then, has the work been done properly. To subject the patient to a surgical correction of the deviation without attempting to treat the amblyopia or develop fusion before or even after operation will result in nothing more than a cosmetic result in from 75 to 80 per cent of cases, even though perfect parallelism may be obtained. The patient will continue to use only the previously fixing eye and will suppress the previously deviating one.

As many of the patients sent to the clinic had a low incidence of spontaneous fusion, we determined to investigate as many cases of surgically corrected strabismus as possible, in order to study the end-results and to make a comparison of the results with those when orthoptic treatment was used.

The results are materially influenced not only by the preoperative treatment given but by the selection of the operative procedure indicated in each case. No one operative technic will be found suitable in all cases of squint, the skill of the surgeon notwithstanding. Each case should be thoroughly studied, and then the indicated surgical

1. Bressler, J. L.: Illinois M. J. **68**:273 (Sept.) 1935.

procedure should be performed. Many operators, having mastered the technic of one surgical procedure, attempt to obtain correction in all cases of squint with the same type of operation, and failure must often result. After free tenotomy and at times after so-called guarded tenotomy, overcorrection on secondary deviation often develops. After the tucking operation also, if this alone is performed without regard to the condition of the opposite muscle, which so frequently may present a secondary contraction, failure frequently occurs. In group 3 of our series, as shown in table 2, the best results were obtained with well-balanced resection and recession or, as Berens so aptly called it, retroplacement. In most of these cases orthoptic treatment was attempted before and again after operation.

There have recently appeared several articles in which the results of the surgical correction of strabismus followed by orthoptic treatment were discussed. Lordan [2] described the results obtained with orthoptic treatment following operation in sixty cases. He made no comment on the state of fusion in these cases before operation, but he did state that with orthoptic treatment after operation he was able to develop fusion in forty cases. His results were favorable, and his opinion was that orthoptic treatment is highly useful. Hicks and Hosford,[3] on the other hand, reporting on twenty-four cases of strabismus with surgical correction without the use of orthoptic treatment, found that some degree of fusion developed spontaneously in sixteen of their patients, or in about 66 per cent.

Our experience has been different. We found that fusion developed spontaneously in only about 8 per cent of the patients who were operated on but who did not receive orthoptic treatment. Jameson,[4] O'Connor [5] and Bielschowsky [6] have stated that orthoptic training is of little value. However, Peter,[7] Cantonnet,[8] Maddox,[9] Guibor [10] and Feldman [11] have expressed high regard for it.

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2. Lordan, John P.: Orthoptic and Surgical Management of Strabismus: Report of Sixty Cases, Arch. Ophth. **12**:843 (Dec.) 1934.

3. Hicks, Avery M., and Hosford, George N.: Orthoptic Treatment of Squint, Arch. Ophth. **13**:1026 (June) 1935.

4. Jameson, Chalmers P.: Personal communication to the author.

5. O'Connor, Roderic: Personal communication to the author.

6. Bielschowsky, A.: Personal communication to the author.

7. Peter, Luther C.: Symposium on the Treatment of Nonparalytic Squint, Tr. Ophth. Soc. U. Kingdom **52**:325, 1932.

8. Cantonnet, A., and Filliozatt, J.: Strabismus, London, M. Wiseman & Company, 1934.

9. Maddox, M.: The Orthoptic Treatment of Strabismus, Tr. Ophth. Soc. U. Kingdom **51**:296, 1931.

10. Guibor, George P.: Some Possibilities of Orthoptic Training, Arch. Ophth. **11**:433 (March) 1934.

11. Feldman, Jacob B.: Orthoptic Treatment of Concomitant Squint, Arch. Ophth. **13**:419 (March) 1935.

Our findings have led us to adopt a middle course. Our results following attempts to correct strabismus with orthoptic treatment alone were not as good as those claimed by Guibor and Cantonnet, but we still feel that in many properly selected cases good results will be obtained by orthoptic treatment without surgical intervention, and efforts expended in this direction are always worth while. However, we have found that orthoptic treatment has its greatest field of usefulness when combined with operation.

We were able to study the records of two hundred and eighteen patients, and we found it best to divide these into the following three groups in order to bring out the comparative results with various forms of treatment:

Group 1. All patients in whom correction was attempted with surgical intervention only.

Group 2. All patients in whom correction was attempted with surgical intervention first and then with orthoptic treatment.

Group 3. All patients who received orthoptic treatment first followed by operation and by orthoptic treatment.

Our best results were obtained in the series of patients in group 3, in which orthoptic treatment was administered before and after surgical correction was attempted. The patients in this group were not specially selected, except that we ruled out all those having any demonstrable pathologic condition, and no patient with paralysis or paresis was included. Patients with poor vision and also those with false fixation were included.

Table 1 shows nothing significant except for the incidence of alternating convergent strabismus, which in our series showed a higher percentage than is usually noted.

A study of table 2 proves our contention that orthoptic treatment combined with surgical intervention gives better results than surgical intervention alone. In group 1 only 32 per cent of the patients had straight eyes, and only 8 per cent showed any tendency toward spontaneous fusion. Of the forty-eight straight eyes, only twelve, or 25 per cent, showed any tendency toward fusion. In group 2, only two patients, or 6 per cent, had parallel eyes before orthoptic treatment was given, and only three patients, or 9 per cent, showed any tendency toward spontaneous fusion. After orthoptic treatment had been given, fifteen, or 47 per cent, were straight, and twenty-four, or 75 per cent, had acquired some degree of fusion. In group 3 the eyes of seven, or 19 per cent, showed some tendency to fuse before operation, and after operation twenty, or 56 per cent, were straight and twenty-nine, or 81 per cent, had acquired the ability to fuse.

The results shown in table 3 surprised us. Thirty-four tucking operations were done, and in fifteen cases parallel eyes resulted. This was unexpected, but we did notice that in many of these cases in

TABLE 1.—*Treatment of Strabismus in Two Hundred and Eighteen Cases*

	Convergent Strabismus, 191 Cases, 88 per Cent		Divergent Strabismus, 27 Cases, 12 per Cent		
	Alternating	Monolateral	Alternating	Monolateral	Total
Group 1	41	89	6	14	150
Group 2	15	14	3	0	32
Group 3	20	12	3	1	36
Totals	76	115	12	15	218
Percentage	40	60	44	56	

TABLE 2.—*Data on the Operative Results*

	Before Operation		After Operation	
	No. of Cases	Per Cent	No. of Cases	Per Cent
Group 1 (operation only; 150 cases)				
Deviation				
15 to 50 degrees	150	100		
Straight eyes	..	..	48	32
Undercorrection less than 15 degrees	..	..	67	
Undercorrection over 15 degrees	..	..	26	
Overcorrection	..	..	9	
Fusion				
None	150	100	138	92
First degree	0	..	7	8
Second degree	0	..	2	
Third degree	0	..	3	
Group 2 (operation followed by orthoptic treatment; 32 cases)				
Deviation				
Straight eyes	2	6	15	47
Undercorrection less than 15 degrees	15	..	8	
Undercorrection over 15 degrees	5	..	5	
Overcorrected	10	..	4	
Fusion				
None	29	91	8	25
First degree	2	9	3	75
Second degree	0		7	
Third degree	1		14	
Group 3 (orthoptic treatment before and after operation; 36 cases)				
Deviation				
15 to 45 degrees	36	100		
Straight eyes	..	..	20	56
Undercorrection less than 15 degrees	..	..	11	
Undercorrection over 15 degrees	..	..	4	
Overcorrection	..	..	0	
No record	..	..	1	
Fusion				
None	29	81	7	19
First degree	3	19	6	81
Second degree	2		8	
Third degree	2		15	

which nothing was done to the internal rectus muscles motility was limited and fusion was difficult. In group 3 it will be noticed that the best results were obtained with the combined recession and resection operation.

In all, two hundred and forty-one operations were performed on two hundred and eighteen patients. In eleven patients both eyes were operated on. Eighty-two, or 38 per cent, of the two hundred and eighteen patients had parallel eyes. Secondary divergence was found in eleven eyes after tenotomy.

The study of visual changes in these cases was rather difficult. With the patients in group 1 we had no contact at all except for one examination prior to the commencement of this study. The records were rather meager and incomplete. We decided to omit the study of vision in this group entirely.

With group 2 we were more fortunate, and for the vision before operation we used the records made when the patient was admitted to

TABLE 3.—*Data on Results Obtained by Different Operations*

Type of Operation	Group 1		Group 2		Group 3		Total	
	Operations	Straight Eyes	Operations	Straight Eyes	Operations	Straight Eyes	Operations	Straight Eyes
Resection with recession	31	7	2	1	20	12	53	20
Resection with advancement and recession	8	2	2	0	5	4	15	6
Recession	4	1	0	0	1	0	5	1
Tucking	26	13	6	2	2	0	34	15
Resection	7	2	1	0	4	2	12	4
Tucking with tenotomy	20	7	9	4	0	0	29	11
Resection with advancement	7	0	3	1	4	1	14	2
Tenotomy	25	6	2	1	1	1	28	8
Resection with advancement and tenotomy	28	7	9	5	2	0	39	12
Tucking with recession	8	2	0	0	0	0	8	2
Cinch	1	0	0	0	0	0	1	0
Cinch with tenotomy	3	1	0	0	0	0	3	1
Totals	168	48	34	14	39	20	241	82

the clinic, having been referred from some other service. The final results were determined just before this study was commenced. The vision of fifteen patients in this group was improved so that they could read from one to four lines more, but no striking improvement was shown in any.

The visual changes in the patients in group 3 were slight, as most of those that had amblyopia had already received suitable treatment for this condition before operation, and any improvement that was possible had already been obtained.

CONCLUSIONS

It is apparent that the end-results are considerably influenced by the efficiency of the preoperative treatment and the preparation of the patient. The importance of careful examination, diagnosis and refraction in these cases before a selection of the form of treatment is made is well known. Yet in many instances I have seen a patient given operative treatment with little preliminary treatment, and in some cases

with none at all. Some surgeons neglect to make a careful preliminary examination and preparation of the patient in their eagerness to perform another operation. This accounts for many of the failures in the surgical treatment of squint.

The type of operation performed also has an influence on the end-results. We feel that in our hands well balanced resection with retroplacement or recession gives the best results. After this type of operation we were able to develop fusion in more patients than after any other type. The tucking operation, although resulting in a good average number of parallel eyes, was unfavorable when considered from the standpoint of the development of fusion. Few patients acquired fusion after tucking operations, even though they had straight eyes.

A comparison of the three groups indicates at once the efficiency of orthoptic training when used in conjunction with surgical intervention. In group 1 spontaneous fusion of any degree developed in few patients. Few of those in group 2 also had spontaneous fusion before orthoptic treatment was given. Orthoptic treatment, in this group, developed fusion in many more and influenced many of the undercorrected and overcorrected eyes, so that in many more cases parallelism developed. In group 3, when orthoptic treatment was attempted before operation and then resumed after operation, a large percentage acquired fusion. The average number of parallel eyes was highest in this group.

This paper has been presented to stress the need and value of orthoptic treatment in combination with surgical treatment, and a plea is made for its routine use in the development of fusion after operation, as the incidence of spontaneous fusion otherwise is low.

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ABSTRACT OF DISCUSSION

DR. CONRAD BERENS, New York: I agree with Dr. Bressler that the best results may be obtained when orthoptic treatment is administered before and after surgical correction; this statement is borne out by our former reports (*Am. J. Ophth.* **12:** 720, 1929; *Tr. Am. Ophth. Soc.* **32:** 245, 1934).

In the department of Motor Anomalies of the New York Eye and Ear Infirmary and in the Lighthouse Eye Clinic, my associates and I have obtained the following results in the treatment of certain patients with strabismus: In a group of forty-three patients in the clinic with heterotropia (similar to Dr. Bressler's group 1) who received no preoperative or postoperative orthoptic training, only one patient (2 per cent) attained fusion without artificial means other than lenses and prisms.

Among a group of forty-eight patients seen in private practice and in the clinic (similar to Dr. Bressler's group 2) who received postopera-

tive orthoptic training, twenty (43 per cent) acquired third grade binocular vision; twelve (25 per cent) had second grade binocular vision; two (4 per cent) had first grade binocular vision, and fourteen (28 per cent) had no binocular vision. Seventeen (twelve with correction and five without correction [36 per cent]) had fusion at 6 meters and 25 cm., and two (4 per cent) had fusion for distance or for near vision with correction. Twenty-eight (58 per cent) had no fusion, and there was no record in one case (2 per cent).

In a group of sixty-five patients who received no preoperative or postoperative orthoptic training (similar to Dr. Bressler's group 3), preoperatively nineteen had some degree of binocular vision; twenty-five (39 per cent) had no binocular vision, and there was no record of binocular vision in twenty-one (32 per cent). Postoperatively thirty-one (48 per cent) had third grade binocular vision; thirteen (20 per cent) had second grade binocular vision, and six (9 per cent) had first grade binocular vision. There was no true binocular vision in fifteen (23 per cent), of which eleven (73 per cent) had false projection. Fusion with the screen test existed in seventeen (25 per cent) with correction and in nine (14 per cent) without correction; four (6 per cent) had fusion for distance only, and two (3 per cent), for near vision only.

We believe that many patients have false projection. Among one hundred and twenty-six patients examined at the New York Eye and Ear Infirmary and at the Lighthouse Eye Clinic, thirty-three (25 per cent) had false projection before orthoptic training, while thirteen (10 per cent) had false projection after orthoptic training.

The statistical data in these studies were compiled by Mrs. H. W. Howe and Miss Dorothy Kern.

Because Dr. Bressler's and my findings and conclusions agree so closely it may be valuable for ophthalmologists who still doubt the efficacy of orthoptic training to study our cases, methods and statistics and show us and ophthalmologists in general where we are in error or how we may improve on our treatment in these cases. I am sure that Dr. Bressler would join me in welcoming this type of scientific investigation, and I wish to thank him for his many valuable suggestions.

Dr. Albert N. Lemoine, Kansas City, Mo.: When one is confronted with a patient having strabismus the first procedure is estimation of the refraction with atropine and prescription of a full correction. It is also essential in prescribing the glasses to correct a great portion of any existing vertical deviation. If the squint is confined to one eye the vision of the deviating eye should be developed either by covering or by atropinizing the fixing eye until the vision is equal in both eyes. Once this has been accomplished, if the patient is old enough, orthoptic training should be instituted and continued until a moderate degree of fusion has been developed, and incidentally one may determine whether the strabismus can be corrected with glasses and orthoptic training. In my opinion, no strabismus can be said to require surgical intervention until this much has been done. Should the squint prove to require surgical intervention, the only further procedure necessary is an accurate measurement of the degree of deviation for near vision and for distance to help determine the operative procedure most suitable in the particular case and the amount of correction necessary.

There are but two types of operation for this condition: recession of the overacting muscle, as first advocated by Dr. R. J. Curdy, or shortening of the underacting muscle, or, possibly, a combination of the two in cases in which there is marked deviation. At one time or another I have used most of the shortening operations; the results varied according to the dexterity with which I was able to perform the operation. Contrary to Dr. Bressler's experience, the results with the tucking operation in my cases were as good as if not better than with most of the other shortening operations. I attribute the better success obtained with some operations to the fact that I have mastered the technic of those operations more perfectly than that of some of the others. Patients with strabismus, if old enough, are operated on preferably under local anesthesia, and the degree of deviation is measured with a Maddox rod before the conclusion of the operation. To obtain a good final result it is necessary at the time of the operation to overcorrect the squint 15 prism diopters. After a week or ten days the orthoptic training should be resumed. After from two to four weeks the refraction should be estimated again, care being taken to correct most of the vertical deviation in the glasses and prescribe the spherical correction according to the muscle balance found at that time. If in convergent strabismus the lateral deviation is undercorrected, the plus correction should be stressed; if it is found to be overcorrected, the plus correction should be made sparingly according to the amount of overcorrection. The opposite holds true in divergent strabismus. The follow-up care should be continued for several years, with a check-up of the muscle balance, vision and fusion at each examination and emphasis on the importance of wearing the glasses if they are needed. I have had several of my perfect results spoiled by vain girls' removing their glasses when they reach the high school age.

Dr. J. L. Bressler, Houston, Texas: In this paper I did not expect to go into the phases of fusion or give a definition of fusion. Dr. Berens said that he performs recession on one eye first and then on the other. I believe that Dr. Jameson does something similar. I do not do that. I do recession and resection on one eye, both at the same sitting, provided the deviation is sufficient to warrant that much correction, and seldom have I had to perform a second operation. So far, in group 3, of thirty-two patients, no patient has had more than one operation, although there are several who I think will need it before the strabismus will be corrected entirely.

Dr. Lemoine feels that tucking gives him the best results. That may be so. There are many surgeons who have mastered the technic of tucking, the technic of resection or advancement or the technic of recession alone. They may obtain good results, but the good results are not measured by parallelism only. If one measures the good results by parallelism plus improvement of vision plus fusion, then one has good results, but many surgeons overlook these factors. When they obtain parallelism in any eye on which they operate they are pleased with the result and often that is as far as the matter goes.

Dr. Lemoine also claimed that if a patient does not have fusion before operation fusion cannot be developed afterward. I have several patients in my clinic who have demonstrated that this is false. One was a woman 28 years of age on whom I operated a little over a year ago.

As far as I determine from her history, she has always had squint. She came for consultation at the age of 28 with no fusion, with alternating strabismus of 30 degrees. No fusion could be elicited. Six weeks after the operation four weeks following orthoptic training, she showed improvement. In from four to six weeks following this, fusion began to develop, and after slightly more than a year she now has all degrees of fusion and perception.

BLUE APPEARANCE OF THE FUNDUS CAUSED BY PROLONGED INGESTION OF METHYLTHIONINE CHLORIDE

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AND
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In the course of routine examinations of the fundi three patients were noted whose fundi presented an unusual appearance. All three patients had taken methylthionine chloride U. S. P. (methylene blue) over a long period, and their fundi appeared deep blue, as though seen through a blue filter. To our knowledge such a condition has not been recorded previously. We are therefore reporting these unusual cases, giving a foreword concerning methylthionine chloride.

Methylthionine chloride was isolated chemically for the first time in 1876 by Caro. It is a tetra-methylthionine chloride, the formula being $C_{16}H_{18}N_3SCl + 3H_2O$. It is dark bluish green with a metallic luster and is odorless and relatively stable. Alcohol and water dissolve the crystals readily. As early as 1880 this dye was used as an intestinal antiseptic to destroy lower forms of plant and animal life. Soon it was shown to have an affinity for living chromatin and axis-cylinders of nerve fibers. This peculiar property led to its use as an analgesic in cases of neuralgia and sciatica. Since its discovery, methylthionine chloride has been used in the therapy of a large number of diseases, for instance, malaria, gonorrhea, corneal ulcer, cystitis, pyelonephritis, tonsillitis, erysipelas and stomatitis.[1] Most recently it has been used as an antidote, as in poisoning due to carbon monoxide,[2] and as an analgesic in tuberculous cystitis.[3]

From the Ophthalmological Service of the Montefiore Hospital.

Read before the Section of Ophthalmology, the New York Academy of Medicine, Feb. 17, 1936.

1. Hinman, F.: An Experimental Study of the Antiseptic Value in the Urine of the Internal Use of Hexamethylenamin, J. A. M. A. **61**:1601 (Nov. 1) 1913.

2. Haggard, H. W., and Greenberg, L. A.: Methylene Blue: A Synergist, Not an Antidote for Carbon Monoxide, J. A. M. A. **100**:2001 (June 24) 1933. Brooks, M. M.: Am. J. Physiol. **102**:145, 1932. Hanzlik, P. J.: Methylene Blue as Antidote for Cyanide Poisoning, J. A. M. A. **100**:357 (Feb. 4) 1933.

3. Greenberg, B. E., and Brodny, M. L.: New England J. Med. **209**:1153, 1933. Greenberg, B. E.; Brodny, M. L.; Davis, T. L., and Armstrong, C.: J. Urol. **33**:168 (Feb.) 1935.

As a drug, it is administered by mouth. It is rapidly absorbed from the intestinal tract, as quickly as fifteen minutes after ingestion, and is distributed to all the tissues of the body. Excretion takes place chiefly through the kidneys, from 50 to 70 per cent being excreted by that route. From 4 to 8 per cent is excreted by way of the gastro-intestinal tract, the element unaccounted for probably remaining in the tissues.

Administered in small doses intravenously, methylthionine chloride causes a rise in the blood pressure. In large doses it may cause shock and death. In human beings it may produce urinary irritation, gastric upsets, pain in the chest, burning in the mouth and changes which are manifest in electrocardiograms, such as a reduction in the voltage of the R wave and reversal of the T wave.[4]

As a germicide methylthionine chloride is weak and will not kill staphylococci, streptococci or Bacillus coli in less than twenty-five minutes, even in dilutions of 1 : 10. However, it will inhibit bacterial growth even in dilute solutions.[5]

After absorption methylthionine chloride remains in the tissues in a colorless form known as leukomethylene blue. Only in the presence of oxygen does the blue reappear.[6] In this form it remains in all the tissues of the body. There is no "hemato-encephalic" barrier for methylthionine chloride, such as exists for other vital dyes, so it is deposited in the brain. We have been privileged to see the organs of a patient who had been given methylthionine chloride (50 cc. of a 1 per cent solution intravenously) therapeutically and who had used carbon monoxide with suicidal intent. On exposure to air all the organs including the brain changed from a normal color to blue in a few seconds. Incisions into the depths of organs such as the brain revealed a quick change from normal gray-white to green-blue.

The reports of the three cases previously mentioned are as follows:

CASE 1.—E.T., a man aged 33 years, was admitted to the medical service of the Montefiore Hospital on Aug. 31, 1935, because of polycystic kidneys. For the severe pain in the loins methylthionine chloride had been given by mouth, 6 grains (0.39 Gm.) three times daily, for four years, starting in June 1931. In this case the drug was used as a urinary analgesic.

On ophthalmoscopic examination the fundi appeared greenish blue, as though seen through a blue filter (as shown in the accompanying figure). The vessels of the fundus were somewhat thin and irregular. The disks were clear, and no hemorrhage or exudate was seen. In the left eye a large patch of myelinated nerve fibers was seen, which did not appear blue. Vision, the visual fields and color vision showed no departure from the normal.

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4. Nadler, J. E.; Green, H., and Rosenbaum, A.: Am. J. M. Sc. **188**:15, 1934.

5. Marshall, D. G.: Lancet **1**:1334, 1920.

6. Abell, R. G.: Anat. Rec. **60**:161 (Sept. 25) 1934. Barron, E. S. G.: J. Exper. Med. **52**:447 (Sept.) 1930.

The appearance of the fundus after the prolonged ingestion of methylthionine chloride.

CASE 2.—J. K., a man aged 50, was admitted to the surgical sevrice of the Montefiore Hospital on Nov. 10, 1935, because of tuberculous kidneys and tuberculous cystitis. For dysuria methylthionine chloride had been given by mouth, 2 grains (0.13 Gm.) three times daily, for one and one-half years.

Ophthalmoscopic examination revealed the same greenish-blue hue seen in case 1. The nerve heads were normal, as were also the vessels. In the macular region the blue appeared most pronounced.

The patient died on December 19, and the eyes were obtained for examination. Mr. Burchell, of the New York Eye and Ear Infirmary, prepared a specimen for us. When the eye was opened it was seen that the vitreous was blue. After the process of dehydration and fixation this color seemed less marked although it was still clearly visible after the specimen was embedded in pyroxylin. Sections revealed no evidence of blue in any cells or in the retina or other coats of the eye. One eye was studied by Dr. J. Smoleroff.

Postmortem examination was performed about two hours after death. The skin over the entire body was brownish with a distinctly bluish tinge. In both groins the skin was greenish blue. The skin of the scrotum over the left testis was firmly adherent and presented a shallow ulceration about 3 cm. in diameter. At the edge of the ulcer were several sinus tracts which discharged thick, greenish-blue necrotic material. The finger-nails were slightly greenish blue.

About one-half hour after the heart was opened the valves and a small portion of the adjacent endocardium became distinctly greenish blue. The lungs contained numerous tuberculous lesions, including in the upper lobes several cavities filled with caseous material. After a short exposure to the air the lungs and more markedly the caseous material became green-blue. The spleen, liver, gallbladder, pancreas, gastro-intestinal tract and adrenal glands showed no evidence of staining with methylthionine chloride.

The left kidney was absent, and at the site of its hilus was an area of caseous material about the size of a hen's egg. The pelvis of the right kidney was markedly dilated. The surface of this kidney presented numerous elevated nodules filled with caseous material, all of which became blue after exposure to the air. The mucosa of the pelvis and ureters also was blue. A rectovesical sinus tract communicated with the seminal vesicles through another large sinus tract. The bladder, prostate gland and rectum became blue almost immediately after exposure. The intimal surface of the aorta also appeared blue, especially in the sclerotic plaques. After a portion of the vertebrae was removed the intervertebral disk became definitely blue. The brain and spinal cord were not removed.

CASE 3.—M. E., a man aged 32, was admitted to the Montefiore Hospital on Jan. 19, 1935, because of pulmonary tuberculosis. In 1932 nephrectomy was performed for tuberculosis of the kidney, and the patient continued to suffer from tuberculous cystitis. For this condition methylthionine chloride had been given since June 1933, 2 grains (0.13 Gm.) three times daily. In August 1935 the ophthalmoscopic picture showed the same bluish hue as described in the other two cases. Again there were no visual disturbances.

In consequence of the observations that have been reported we have assumed that the methylthionine chloride by diffusion entered the vitreous body, which acted as a blue filter, producing the ophthalmoscopic picture described. The color was lost over the patch of myelinated fibers, possibly because of the relatively large amount of light reflected at this point. It is also possible that the dye was deposited

in the neuro-epithelium of the retina and that dehydration and fixation may have dissolved it out. We are unable to state at this time the amount of dye which is necessary to produce this picture or the length of time required for the color to disappear. In case 1 the fundus remained blue for six months after the use of the drug was discontinued. Why the dye does not exist as leukomethylene blue in the eye is problematic. There is a possibility that it is because of the rapid oxidative processes in the eye or the direct diffusion of oxygen from the cornea.

We have been able to reproduce this picture in rabbits but have been unsuccessful in observing the dye in any of the coats of the eye. This, we believe, may be due to the fact that we have not been able to fix the dye properly because of its ready solubility.

It is felt that the picture which we have presented is worth bearing in mind when one is examining a patient who has taken methylthionine chloride for a long time.

SUMMARY

Three cases are presented in which the fundi were blue as a result of prolonged ingestion of methylthionine chloride.

We believe that this coloration is due to the presence of the dye in the vitreous body.

The presence of this dye does not alter the visual acuity or color vision in any way.

Drs. H. Wessler, A. A. Berg and L. Lichtwitz permitted us to report these cases.

CATARACT FOLLOWING DI-NITROPHENOL TREATMENT FOR OBESITY

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SAN FRANCISCO

An excellent review of the subject of di-nitrophenol in general was given in a report by the Council on Pharmacy and Chemistry of the American Medical Association,[1] from which I shall quote freely.

The actions of certain nitro derivatives of phenol and naphthol as accelerators of metabolism have been studied for the past fifty years. Cazeneuve and Lepine [2] in 1885 described the increase in the metabolism of dogs given di-nitronaphthol. A few years later Gibbs and Reichert [3] reported similar observations with the use of di-nitrophenol.

During the war many cases of di-nitrophenol poisoning were observed among French munition workers. The poisoning, which was often severe and sometimes fatal, occurred so frequently that special pharmacologic study was instituted. The findings were reported on by Magne, Mayer and Plantefol [4] in France and by Perkins [5] in America.

In 1933 Tainter and Cutting [1] and their coinvestigators, proceeding independently, confirmed much of the work cited in the French and Belgian reports. In exhaustive researches they verified the previous observation that di-nitrophenol can increase the consumption of oxygen in animals to more than ten times the normal value. They attributed the increase in the metabolism to a direct peripheral stimulation of cellular activity. This varied with the dose. When large doses were given the animals produced heat so fast that they were sometimes killed

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From the Department of Ophthalmology, the University of California Medical School.

Read before the Section on Ophthalmology at the Eighty-Seventh Annual Session of the American Medical Association, Kansas City, Mo., May 13, 1936.

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2. Cazeneuve, P., and Lepine, R.: Sur les effets produits par l'ingestion et l'infusion intraveneuse de trois colorants paunes, dérivés de la houille, Compt. rend. Acad. d. sc. **101**:1167, 1885.

3. Gibbs, W., and Reichert, E. T.: Am. Chem. J. **13**:289, 1891.

4. Magne, H.; Mayer, A.; Plantefol, L.; Guerbet, M.; Gor Georgescu, J., and Vlès, F.: Etudes sur l'action dinitrophenol 1-2-4, Ann. de physiol. **7**:269, 1931; **8**:1, 1932.

5. Perkins, R. G.: A Study of Munitions-Intoxications in France, Pub. Health Rep. **34**:2335 (Oct. 24) 1919.

by the resulting fever. The fatal dose for animals was found to be about 20 or 30 mg. per kilogram of body weight. The rise in temperature was independent of the control of the brain or spinal cord. The drug caused a decrease in the amount of glycogen in the liver and muscles, while the amount of sugar and lactic acid in the blood and muscles increased. There was good evidence that not only carbohydrates but body fats also were burned up by increased oxidation. Repeated administration of the drug to dogs for six months, with doses just short of being fatal, failed to cause significant injury to the vital organs, as shown by functional tests and pathologic examinations.

In human beings the action of di-nitrophenol agreed closely with that in animals in equivalent doses. In July 1933 Cutting, Mehrtens and Tainter [1] reported that nine patients had been given from 3 to 5 mg. of the drug daily for prolonged periods and that weight was lost without dietary restrictions. No undesirable symptoms were encountered, and the patients stated that they felt better and more active than before. Changes in the temperature, pulse rate or respiratory rate were not observed, although the amount of perspiration was increased. The authors stated as their conclusion that di-nitrophenol "may be useful in the treatment of obesity, hypo-thyroidism and similar depressed metabolic states." They pointed out that there are limits and potential dangers in the clinical use of the drug and that it should be used only under strictly controlled conditions.

This warning was repeated simultaneously in a report by the Council on Pharmacy and Chemistry of the American Medical Association [6] and in an editorial in *The Journal of the American Medical Association*.[7] In spite of these warnings, di-nitrophenol came to be used widely in the treatment of obesity. It is estimated that probably one hundred thousand persons used the drug for the reduction of weight during the first fifteen months after its introduction. Forty-five hundred of these patients were treated in California alone.[8] Commercial concerns came to supply both di-nitrophenol and mixtures containing it.[9]

Under those circumstances it is not surprising that observations on toxic manifestations began to be reported in the literature. These consisted most often of cutaneous eruptions and similar results of intoxication, as mentioned by Tainter, Stockton and Cutting; Anderson, Reed

6. Alpha-Dinitrophenol, Preliminary Report of the Council on Pharmacy and Chemistry, J. A. M. A. **101**:210 (July 15) 1933.

7. Dinitrophenol: A Metabolic Stimulant, editorial, J. A. M. A. **101**:213 (July 15) 1933.

8. Tainter, M. L.; Cutting, W. C., and Stockton, A. B.: Use of Dinitrophenol in Nutritional Disorders, Am. J. Pub. Health **24**:1045 (Oct.) 1934.

9. Dangers of Slimming, editorial, J. A. M. A. **105**:804 (Sept. 7) 1935.

and Emerson; Haft; Sidel; Frumess; Hirsch, and Jackson and Duval;[1] congestive infection of the ear, as reported by Dintenfass;[1] jaundice, as reported by Sidel;[1] agranulocytic angina, as reported by Bohm, Silver, Hoffman, Butt and Hickey;[1] peripheral neuritis, as reported by Nadler,[10] and abortion, as reported by Epstein and Rosenblum.[11] Haft[1] and Sidel[1] and MacBryde and Taussig[12] reported functional damage of the liver, heart and muscles.

Seven fatalities were reported by July 1935 by Silver, Tainter and Wood; Geiger, Poole and Haining; Masserman and Goldsmith,[1] and Leutsker.[13] In the majority of cases death occurred within twenty-four hours after the onset of such toxic manifestations as dizziness, fatigue, dyspnea, high fever and excessive perspiration. As had been noted in animals, rigor mortis set in promptly after death.

On July 6, 1935, the Council on Pharmacy and Chemistry of the American Medical Association recommended that di-nitrophenol should not be accepted for inclusion in "New and Nonofficial Remedies."[1] In arriving at this conclusion they pointed out that di-nitrophenol, as a new drug, should await further study in laboratories and clinics before being put into general use as a remedy for obesity. They stated further that "to treat a mild chronic condition such as obesity with a toxic agent capable of inducing serious injury and death appears to be unjustified." They recommended that restrictions be placed on the sale of the drug and that its use be limited to selected patients supervised by properly trained physicians. The dangers of di-nitrophenol had already received official recognition in Germany,[14] Canada[15] and England.[16]

Nearly two months prior to the Council's adverse report on di-nitrophenol, suspicion had been cast on the drug as a possible cause of cataract. In April 1935 a woman of 50 was referred to me by Dr. Richard Jones, because of blurred vision of recent appearance. Vision was 1/10 (?); corrected, it was 3/10 in each eye. Examination revealed bilateral incipient cataracts. Consultation with Dr. Jones disclosed that

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10. Nadler, J. E.: Peripheral Neuritis Caused by Prolonged Use of Dinitrophenol, J. A. M. A. **105**:12 (July 6) 1935.

11. Epstein, E., and Rosenblum, H.: Peripheral Neuritis and Abortion Following Dinitrophenol Therapy: Case, J. Lab. & Clin. Med. **20**:1118 (Aug.) 1935.

12. MacBryde, C. M., and Taussig, B. L.: Functional Changes in Liver, Heart and Muscles and Loss of Dextrose Tolerance Resulting From Dinitrophenol, J. A. M. A. **105**:13 (July 6) 1935.

13. Leutsker, R. J.: Instance of Circulatory Collapse Attributed to Dinitrophenol, U. S. Nav. M. Bull. **33**:394 (July 6) 1935.

14. Reichs-Gesundh.-Bl. **52**:1078, 1934.

15. Bar Sale of Dinitrophenol [in Canada], medical news, J. A. M. A. **103**: 1243 (Oct. 20) 1934.

16. Medicine and the Law: Dekrysil Treatment; the Paddington Inquest, Lancet **1**:652 (March 24) 1934.

the patient was in excellent physical condition except for a moderate degree of obesity. The history showed no indications of the action of extraneous toxins, glandular deficiency (tetany) or other factors which might have some bearing on the condition of the eyes. The patient had been taking di-nitrophenol for the reduction of weight. Since the cataracts gave the impression of being due to some toxic influence, di-nitrophenol was suggested as the cause. I communicated with Dr. M. L. Tainter, an authority on this drug, but he knew of no ocular disturbances in any of his series of patients or in the patients whose cases had been reported in the literature.

Shortly after that my colleagues and I examined the eyes of another patient under similar treatment with di-nitrophenol. She also complained of visual disturbances and showed changes in the lens similar to those in case 1. The history and physical findings likewise were unimportant. This further aroused suspicions, until it was determined to examine the eyes of as many patients under di-nitrophenol treatment as possible. One more instance of changes in the lens was observed among twenty-three patients examined with the slit lamp. These cases served as the basis for our original report [17] and for additional articles by W. W. Boardman,[18] recommending that the use of di-nitrophenol be stopped pending further observation.

Milton Shutes,[19] of Oakland, reported three similar cases about that time. One of the patients, a woman of 39 years, had noted blurring as early as October 1934. By January 1935 vision had been reduced to perception of large objects. This patient and Kniskern's [20] were apparently the first to show visual disturbance after the use of di-nitrophenol. It is interesting that in two of Kniskern's patients acute hypertension developed which required surgical intervention. Additional cases were reported by Cogan and Cogan,[21] Lazar,[22] Allen and Benson [23] and

17. Horner, W. D.; Jones, R. B., and Boardman, W. W.: Cataracts Following the Use of Dinitrophenol: Preliminary Report of Three Cases, J. A. M. A. **105**:108 (July 13) 1935.

18. Boardman, W. W.: Rapidly Developing Cataract After Dinitrophenol, J. A. M. A. **105**:108 (July 13) 1935; California & West. Med. **43**:118 (Aug.) 1935; Ann. Int. Med. **9**:195 (Aug.) 1935.

19. Shutes, M. H.: Dinitrophenol, Am. J. Ophth. **18**:752 (Aug.) 1935.

20. Kniskern, P. W.: Cataracts Following Dinitrophneol, J. A. M. A. **105**: 794 (Sept. 7) 1935.

21. Cogan, D. G., and Cogan, F. C.: Dinitrophenol Cataract, J. A. M. A. **105**:793 (Sept. 7) 1935.

22. Lazar, N. K.: Cataract Following the Use of Dinitrophenol, J. A. M. A. **105**:794 (Sept. 7) 1935.

23. Allen, T. D., and Benson, V. M.: Late Development of Cataract Following Use of Dinitrophenol About One Year Before, J. A. M. A. **105**:795 (Sept. 7) 1935.

Glowacki.[24] Rodin [25] has collected and analyzed the reports of a series of thirty-two cases in the San Francisco Bay area. This is the largest series of cases to be reported. The author added the histories of about twenty-five new patients. Whalman [26] collected reports of seventeen cases, seven of which were new. Cogan and Cogan [27] have gathered the reports of twenty-five cases.

A total of about fifty cases have been reported, but additional cases have occurred. The total number is more than sixty and probably under one hundred. New cases are still developing. For example, I saw four new patients during February 1936, making a total of eleven cases, all of bilateral involvement.

CHANGES IN THE LENS

The changes in the lens following the administration of di-nitrophenol are fairly uniform. At first I thought they were characteristic enough to be of diagnostic significance when observed under the slit lamp. This view must be modified, for I have since seen two women with early bilateral cataracts who have not taken di-nitrophenol or any reducing remedy and in whom the slit lamp observations were identical with those in the series of patients who had taken di-nitrophenol. Careful examination by an internist failed to show any cause for the changes. In one of these patients the possible absorption of drugs contained in contraceptives which had been used over a long period was considered. The earliest change consisted of bilateral, faint gray, dust-like opacities just beneath the anterior capsule of the lens. They have been described also as being stippled, polychromatic, striate or downy. By retro-illumination the anterior capsule often appears roughened, dry or vacuolated. This phenomenon is probably due to the optical effect of underlying opacities rather than to actual changes in the capsule itself. The posterior subcapsular layers show a peculiar saucer-shaped granular metallic luster. I prefer to call it a "cloth of gold" reflex. It may resemble brass filings, hammered copper or filed steel. The nucleus and remaining lens are clear. Small, cornmeal-like granules in the cortex of the lens have been mentioned, but in my opinion they are not characteristic of the condition caused by di-nitrophenol. The cornea, iris, vitreous and eyegrounds remain normal.

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24. Glowacki, B. F.: Acute Cataracts Presumably Due to Dinitrophenol Therapy, J. Michigan M. Soc. **34**:535 (Sept.) 1935.

25. Rodin, Frank: Cataracts Following the Use of Dinitrophenol, California & West. Med., to be published.

26. Whalman, H. F.: Dinitrophenol Cataract, Tr. West. Ophth. Soc., to be published.

27. Cogan, D., and Cogan, F.: Cataracts and Dinitrophenol, New England J. Med. **213**:854 (Oct. 31) 1935.

The abnormalities just described may be present while the vision is still normal. The lenticular changes occur rapidly, often progressing with the speed of a traumatic cataract. The opacities invade the cortex and finally the nucleus, so that the whole lens becomes silken gray; later it becomes pearl-like. Late stages frequently show segmentation, with dark wedgelike intervening spaces. The lens swells early in the process, the anterior chamber becomes shallow and the tension rises. In six eyes to my own knowledge acute secondary hypertension has developed, as will be mentioned later.

During the early stage in the development of a cataract the refraction becomes increasingly hyperopic, often amounting to 2 or 3 diopters. This is contrary to the usual myopic tendency of a swollen lens. Hyperopia may disappear, and myopia may ensue by the time the opacity prevents refraction. Sudden subjective visual improvement occurred in Allen and Benson's [23] patient and in two of my patients. This was followed in a short while by a marked visual loss. No explanation is known for this phenomenon.

The cause of the changes in the lens following the administration of di-nitrophenol is not known. Thus far the sole premise is *post hoc, ergo propter hoc*. One may argue that di-nitrophenol is a toxic drug and that it may be capable of injuring the subcapsular epithelium. This is not unlikely but is as yet unproved. Cameron [28] found that a lens extracted from a patient who had taken this drug gave positive results in chemical tests for di-nitrophenol. However, this only follows the demonstration of Bence-Jones,[29] made in 1865, that lithium chloride when ingested by guinea-pigs can be found in the lens.

Cogan and Cogan [21] immersed immature lenses removed intracapsularly in a 2 per cent solution of di-nitrophenol. Additional opacity did not develop; so they concluded that the drug had no precipitating effect on the fibers of the lens. So far, my colleagues and I have no report to make concerning the behavior of the lens following injections of di-nitrophenol into the aqueous or vitreous. Rats, which are susceptible to cataract, do not show cataracts when di-nitrophenol is added to their diet. We have as yet no data to indicate that the increased metabolism produced by this drug has a deleterious effect on the lens. Determinations of the calcium content of the blood of a number of the patients with cataract have shown normal amounts.

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28. Cameron, Walter: Personal communication to the author.

29. Bence-Jones, H.: On the Rate of Passage of Crystalloids into and out of the Vascular and Non-Vascular Textures of the Body, Proc. Roy. Soc., London **14**:400, 1865.

INCIDENCE

The incidence of cataract in patients who have taken di-nitrophenol is not high, probably between 0.1 and 1 per cent. While the total number of cases is hard to estimate, the figure, as has been stated, probably lies between sixty and one hundred. An estimate of the total number of patients in America who have taken di-nitrophenol for obesity is likewise difficult to make, but the number is probably in excess of one hundred thousand.

The amounts of di-nitrophenol taken and the length of the periods during which the drug was used by patients in whom cataract has developed vary widely. One patient in the present series received only 31.6 Gm. in four months. Another patient took more than three and one-half times this amount (114.1 Gm.) in sixteen months. Susceptibility in individual patients, therefore, varies widely. It is noteworthy that the case of only one man has been reported in which there were changes in the lens.

Rodin [25] has collected the reports of a series of thirty-two cases. The average age of the patients was 45 years. In twenty-nine cases di-nitrophenol was taken for an average of eleven months. In twenty-seven cases the average length of time that passed after the drug was first taken until the cataract appeared was fifteen months. In eighteen patients a cataract formed after the use of di-nitrophenol had been discontinued for an average of seven months.

It is remarkable that in France, where di-nitrophenol poisoning among munition workers was so common, reports of cataract have not been made. Dally,[30] in a recent article, remarked that during the last three years millions of patients have used di-nitrophenol in all the countries of the world but that no cases of cataract had resulted until suddenly in America cataracts commenced to appear, although elsewhere, especially in France, no such disorder had been seen. Dally gave as his conclusion that "one must suspect the toxic action of an impurity in the di-nitrophenol, very probably di-nitronaphthol." Against this argument it may be stated that all the di-nitrophenol used in the earlier clinical investigations was tested for purity by the department of pharmacology of Stanford University before being released.

TREATMENT

Medical treatment has failed to cause regression or to prevent progression of any of these cataracts. Local measures, such as hot compresses, ethylmorphine hydrochloride or subconjunctival injections, have been useless. General therapy, consisting of forced fluids, calcium salts,

30. Dally, P.: Du nouveau sur le dinitrophenol, Concours méd. **50**:3491 (Dec. 15) 1935.

diet, rest and cevitamic acid (vitamin C), as advocated by Josephson,[31] likewise have been ineffective.

Surgical Considerations.—Surgical treatment has been successful for the most part. Complications such as anterior hyaloiditis, haziness of the vitreous, intra-ocular hemorrhage and loss of vitreous were mentioned in the discussion of this subject at the meeting of the Western Ophthalmological Society, in Pasadena, Calif., in January 1936 by Whalman,[26] and by Barkan and his associates.[32]

In general, any technic applicable to the extraction of a soft cataract, with preservation of a round pupil, may be used. Needling, linear extraction and extraction through a small Graefe incision have been employed successfully. Intracapsular removal has been carried out by Jones.[33] Since most of these patients are at an age when the zonular fibers are ordinarily resistant, the advisability of the use of this technic is debatable. Moreover, the anterior capsule is unusually tense and does not lend itself to the use of blunt forceps.

My colleagues and I wish to present our results in a series of seventeen extractions. Fourteen of these extractions were performed by me, and I assisted with three others.

In eleven of the cases a narrow Graefe incision was used, one-half the usual size, with a conjunctival flap. This was combined with peripheral iridotomy, broad capsulotomy, expressage by pressure and lavage of the anterior chamber. This technic lends itself to any contingency, since the incision may be enlarged if necessary and can be closed by suture.

In eleven extractions the lens was soft and lardaceous. In six it was firm, and it delivered more like a senile cataract. In the latter instances we were glad that we had not employed a keratome incision, for it would have been too narrow.

When the Graefe section was made, sutures in the lid held by my clamp,[34] which also controls a suture through the superior rectus muscle, were used in place of a speculum. A deep orbital injection and akinesis were employed. The conjunctival flap was sutured.

In four instances immediate operation was made necessary by the precipitation of acute secondary hypertension, leading to an unusual situation which necessitated an emergency extraction of the cataracts. The anterior chamber was at first too shallow to admit passage of a

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31. Josephson, E. M.: Science **82**:222 (Sept. 6) 1935.

32. Barkan, H.; Borley, W.; Fine, M., and Bettman, J.: Operative Results in Cataracts Coincident with Dinitrophenol Therapy, California & West. Med. **44**:360 (May) 1936.

33. Jones, Arthur M.: Personal communication to the author.

34. Horner, W. D.: A Special Clamp for Holding Lid Sutures in Cataract Operations, Am. J. Ophth. **18**:957 (Oct.) 1935.

Graefe knife, but it became deeper after the retrobulbar injection of procaine hydrochloride and epinephrine and instillation of a 2 per cent solution of suprarenin bitartrate. This procedure is recommended, since in most cases of cataract due to di-nitrophenol the chamber is very shallow. Delivery of the lens and convalescence were not complicated by hypertension.

The anterior capsule is always tense in these cases and may be difficult to engage if the capsule forceps is not sharp. It is wise for this reason to have a cystotome ready for use. By the time the operation is to be performed all the lenticular fibers are opaque, so that a pupil which is free from lenticular débris at the end of the operation remains black. No new opacities are found at the first dressing.

The postoperative reaction is not greater than that after an operation for any soft cataract. It may be less, since most of the lenticular fibers are opaque and can be removed at the time of operation.

In six cases linear extraction was performed. In four of these the pupil was fully dilated by a subconjunctival injection of epinephrine, as recommended by Barkan.[35] A keratome was entered 1.5 mm. inside the limbus and plunged boldly into the lens substance. The blade was left in situ to form a guide along which the soft lenticular fibers expelled themselves. The point of the knife was moved about so as to break up solid masses and to encourage their expulsion. In one case this procedure alone was sufficient to remove all the fibers. In the others mild lavage was required.

This technic, which I first saw used by a San Francisco colleague, Dr. Wilber Swett, is excellent for the removal of a soft lens. With this procedure, the shallowest anterior chamber is no handicap.

In two cases linear extraction was performed using a keratome incision, capsulotomy with a sharp forceps, expressage and lavage. While it yielded no better results than the preceding method, the removal of a piece of anterior capsule would have statistical advantages over a simple incision of the capsule.

For persons over 40, however, I prefer a narrow Graefe incision, as it is best adapted to all lenses, regardless of the degree of sclerosis.

OPERATIVE RESULTS

As shown in the table, one anterior chamber did not close for nine days. Iritis developed two days after closure but cleared without damage in eight days, with vision of 8/10. One patient showed severe iritis on the fifth postoperative day. This appeared to be of endogenous origin, possibly connected with three abscessed teeth, which were over-

35. Barkan, Otto: Procedure for Extraction of Congenital, Soft and Membranous Cataracts, Am. J. Ophth. **15**:117 (Feb.) 1932.

looked before operation. Consequently, there were opacities in the vitreous and a lightly clouded capsule, which will require needling. Four eyes showed some degree of anterior synechia. Two of these caused oval pupils.

Results of Operations for Cataract

Case	Patient	Age	Technic*	Preoperative Complications	Postoperative Complications	Results	Vision	Jaeger Test	Comment
1	LL	50	A	.....	None	Round, clear pupil	1.0	0.50	
2	LL	50	A	.....	None	Round pupil	0.8	0.62	
3	EA	38	A	.....	None	Slightly oval pupil	1.0	0.50	
4	EA	38	A	.....	None	Round pupil	0.8	0.62	
5	JL	41	A	.....	None	Round pupil	1.0	0.50	
6	JL	41	A	.....	Anterior chamber formed on 9th day; slight degree of iritis on 11th to 19th day after operation	Round pupil	0.8	0.50	
7	IV	26	A	.....	None	Slightly oval pupil	0.3	1.0	Needling later
8	MP	40	A	.....	None	Round pupil; capsule not clear	0.2	....	Needling later
9	MP	40	A	.....	None	Oval, clear pupil	1.0	0.50	
10	RR	44	A	Acute secondary glaucoma	None	Round, clear pupil	0.8	?	
11	RR	44	A	Acute secondary glaucoma	None	Round, clear pupil	0.8	?	
12	LS	42	B	.....	None	Round, clear pupil	1.0?	....	
13	ZM	46	B	.....	Iritis on 5th day after operation	Capsule, not clear; opacities in vitreous	0.1?	....	Needling later
14	HH	35	B	Acute secondary glaucoma	None	Round, clear pupil	1.0	0.62	
15	HH	35	B	Acute secondary glaucoma	None	Round, clear pupil	0.8	0.62	
16	MPO	35	C	.....	Severe periocular dermatitis	Round, clear pupil	1.0	0.50	
17	MPO	35	C	.....	Slight periocular dermatitis	Round, clear pupil	1.0	0.50	

* A indicates small Graefe incision, sutured flap, peripheral iridotomy, expressage and lavage; B, linear keratome incision continued into the lens, no additional capsulotomy, expressage and lavage; C, linear keratome incision, capsulotomy by sharp forceps, expressage and lavage.

The results of the operations are given in the accompanying table. In fourteen, or 82.3 per cent, of a total of seventeen extractions vision of 0.8 or better was obtained. Only three eyes will require needling.

CONCLUSIONS

Cataracts appear to follow the therapeutic administration of di-nitrophenol in from 0.1 to 1 per cent of cases. The mechanism is at present unknown. The administration of this drug should be withheld pending further study.

Cataracts identical in appearance with these may develop in women who have not taken di-nitrophenol.

A series of seventeen extractions by three different methods is reported, and vision was 0.8 or better in 82.3 per cent of the cases, without secondary operation.

384 Post Street.

ABSTRACT OF DISCUSSION

DR. ARTHUR J. BEDELL, Albany, N. Y.: Dr. Horner's paper is of outstanding importance because it brings to the attention of the ophthalmologist and the internist the inadvisability of using a drug of questionable potentialities.

The first diagnosis of cataract following the administration of di-nitrophenol was made in April 1935. The changes observed in the lens have been variously described as faint gray dustlike opacities just beneath the anterior capsule and metallic granules arranged in a saucer shape beneath the posterior capsule. Dr. Horner has stated that the opacities may increase in size either slowly or with sufficient rapidity to cause an intumescent cataract with secondary glaucoma.

In the cases that I have observed the involvement of the anterior and the posterior cortex was usually that described by Dr. Horner, although I have observed fine granular whitish dots and minute vacuoles immediately beneath the anterior capsule and the typical golden-yellow reflex in the posterior cortex which has always been associated with complicated cataract. The pearly sectors of a quickly forming cataract that comes on spontaneously or after trauma have been thought by some to be characteristic of the condition caused by di-nitrophenol. In one patient in whom there was involvement of the anterior and the posterior cortex the cataract did not go on to complete opacification. Her vision has improved, and the lens is clearing.

The essayist has given a clear, concise description of the methods of treatment which he employed and the results. His tabulated results are sufficient justification for the continuance of his procedure.

Physicians should have some conception of the widespread use of proprietary drugs containing di-nitrophenol. Whalman has found seventeen such nostrums. In the May 2, 1936, issue of *The Journal of the American Medical Association* there is an exposure of one known as "redusols."

The published tables record the not unexpected finding that only one man has been afflicted. Few men try to reduce their girth by means of drugs. There is widespread range as to the age incidence. Many patients are in the decade when cataracts are most often discovered. The majority of patients in whom cataract developed after the use of di-nitrophenol had discontinued the use of the drug months before the inception of the changes in the lens. The only constant

factor was that di-nitrophenol had been taken; the amount varied greatly, and few patients, if any, had toxic symptoms. Therefore, I feel that forensically and practically there is much doubt regarding the actual relation between the absorption of di-nitrophenol and the change in the lens. This is further emphasized when one considers the aforementioned wide range of age, the time which elapsed after the use of the drug, the variability in dosage and that most intangible of all factors, the individual. I am, however, not unmindful of the similarity in the progress of the reported di-nitrophenol cataracts. But when one considers the comparatively few cases of such cataracts on record, certainly less than one hundred at this time, and the wide geographic distribution of the patients, this similarity of the development of the cataracts may be simply coincident.

As yet I am unable to recognize any pathognomonic pathologic changes in the lens following the absorption of di-nitrophenol. All the lenticular changes described have been seen repeatedly in patients who have never taken the drug.

Ophthalmologists of wide experience have seen cataracts develop in the same way in some diabetic patients and in some patients suffering from goiter. I have seen the lens become entirely opaque within seven days and the cortex liquefy in two weeks in a patient who had never taken di-nitrophenol.

DR. ALBERT D. FROST, Columbus, Ohio: This paper leaves no doubt as to the etiology and character of this type of cataract. My inquiries addressed to my colleagues in central Ohio have revealed but a single case. The drug had been prescribed by a physician, and the cataracts developed about nine months after the beginning of its use and one month after its discontinuance, respectively.

Although I have not, either in my practice or in the University Clinic, observed any cases of cataract, I wish briefly to report the findings in a patient who apparently has partial atrophy of the optic nerve as a result of taking di-nitrophenol.

M. O., a single American woman aged 30, had been employed as a capsule filler since November 1929. In January 1934 the company began making capsules of alpha-di-nitrophenol and sodium di-nitrophenol, with which she worked exclusively. Shortly afterward she noted that the drug was staining her fingers, and attempts to remove the discoloration were unsuccessful. The drug was dusty but caused no irritation of the mucosa of the air passages. She noticed a feeling of warmth and exhilaration while thus occupied, which was not present at other times. After three months of this work she noticed marked weakness, nausea and blurred vision. She showed improvement during a short enforced absence on account of these symptoms, but they returned when she resumed the same work. She became progressively weaker, and the temperature ranged from 100 to 102 F. She had moderate edema of the hands, feet and eyelids, with intense itching. She had lost 10 pounds (4.5 Kg.) in weight and was tired and listless. At this time herpes simplex developed over the right eye, accompanied by pain over the right frontal and parietal regions. The cornea and conjunctiva were not involved. Her physician at this time made a diagnosis of acute di-nitrophenol poisoning. After being confined to bed for about a week she returned to work but did not fill any more of the capsules. She

consulted her physician again in January 1935, still tired and listless, but complained chiefly of markedly blurred vision, which was gradually becoming worse. It was at this time that she was referred to me. Vision in each eye was 20/50 with correction. On external examination the eyes appeared normal, with normally active pupils. The fundi showed rather marked narrowing of the vessels and definite pallor of the disks. The visual fields were contracted for form and colors, and the blindspots were enlarged to twice the normal size. No central scotoma was demonstrable. Examination in September 1935 revealed no change in the findings.

From the history and findings in this case it was considered plausible that the absorption of di-nitrophenol either through the skin or through the mucous membrane of the air passages was a factor in causing optic neuritis of toxic origin with secondary atrophy, since other possible causes were ruled out by careful study in the hospital.

The dangers of this treatment of obesity are now so well known that one can scarcely expect to see any more patients with this type of cataract.

DR. EARL WHEDON, Sheridan, Wyo.: The essayist made the statement that there are no cases on record in which cataracts following di-nitrophenol treatment for obesity have cleared up under any medical procedure and that operation is the only hope for restoration of sight.

I wish to put on record the following case in which the use of Dr. Gifford's method of hot water treatment every hour and the instillation of a 4 per cent solution of ethylmorphine hydrochloride three times daily cleared up cataracts.

At a recent meeting of the Montana Ophthalmological Society a young married woman was presented who had lost 90 pounds (40.8 Kg.) in weight by the use of dinitrophenol. I recognized her as a former patient of mine whom I had seen on Sept. 12, 1935. At that time she had developing cataracts in each eye which on examination with the ophthalmoscope showed small specklike opacities and the golden reflex in the posterior capsule. Drawings were made on her record card showing the conditions present. Four weeks later her vision had improved, and five months later it was with difficulty that any traces of cataract could be found in the lenses or capsules.

This was the first patient with this condition in whom improvement had occurred that any of the members had seen.

DR. CHARLES LUKENS, Toledo, Ohio: I have three cases to report. On Oct. 26, 1934, a woman aged 48 was sent to me by her physician because of "blurred vision with her glasses." Both crystalline lenses showed fine scattering opacities, which were especially marked in the posterior capsular layers. Correction with trial lenses gave the following results:

With a + 2.50 sph. + 1.50 cyl. ax. 15°— vision in the right eye was 5/7½, and with a pinhole, 5/5. With a + 1.75 sph. + 1.50 cyl. ax. 165 — vision in the left eye was 5/7½, and with a pinhole, 5/5.

This correction was ordered, but in five weeks the patient returned with further clouding and swelling of the lenses. She accepted a + 1.50 D. sphere and a 1 D. cylinder more for each eye. Such a phenomenon was contrary to all former experiences with cataract forma-

tion. I interrogated her physician and found that he had prescribed di-nitrophenol for her. This was four months before the appearance of the first article on this subject, in the July 13, 1935, issue of *The Journal of the American Medical Association,* by Drs. Horner, Jones and Boardman.

The second patient was a married woman aged 54, who was seen on April 20, 1935, because of "clouded vision and glasses changed three times in the past three months." She was wearing a + 5.50 D. sphere for each eye, but she promptly accepted a sphere of 2.50 D. more for the right eye and one of 3 D. more for the left eye, giving vision of 5/7½ for each eye. She had been taking di-nitrophenol for obesity.

The third patient, a woman aged 34, was seen on Dec. 18, 1935. She had a history of rapidly failing vision. She denied having taken any drug, but later her physician told me that she had been taking di-nitrophenol. She had typical di-nitrophenol cataracts—the lenses were badly swollen, nearly obliterating the anterior chambers. With the right eye she could count fingers at 0.25 meter; vision in the left eye was 5/60.

The first and second patients had preliminary iridectomies in May and August, respectively, and mushy lenses were extracted in September and December, with perfect results. The third patient, who had badly swollen lenses, insisted on immediate relief but was finally put off for one month, when extraction combined with other procedures was performed, a mushy lens readily delivered and the fragments washed out. Recovery was prompt. The corrected vision of the first patient was 5/6; that of the second and of the third patient was 5/5 —. Each of the three insisted on having the second eye operated on as soon as possible, and the operator, having lost some of his timidity from acquaintance with an entirely new problem, granted their request. Extraction combined with capsulotomy and irrigation was performed on each patient on March 31 and April 7 and 9, 1936, respectively. This was followed by better and shorter convalescence than the average operation for ripe senile cataract. No permanent correction has been ordered for the second eyes, but the vision, roughly tested one week after discharge from the hospital, was: for the first patient, 5/7½ with a + 11.00 sph. + 2.50 cyl. ax. 15°—; for the second patient, 5/7½ with a + 13.00 sph. + 1.00 cyl. ax. 180°—, and for the third patient, 5/5 with a + 13.00 sph.

Drs. Horner, Jones and Boardman made note of the rapidly increasing hyperopia in two of their cases and attributed it to flattening or drying of the lenses. In two of my patients a study of the refraction was made before and after operation, the results of which are as follows:

On examination in 1930 the first patient showed a normal state of refraction, the correction for the right eye being a + 1.50 sph. + 0.25 cyl. ax. 180°—, and that for the left, a + 1.25 sph. + 0.25 cyl. ax. 180°—. In 1935 the correction over swollen lenses was a + 4.00 sph. + 1.75 cyl. ax. 15°— for the right eye and a + 3.25 sph. + 2.50 cyl. ax. 165°— for the left.

After extraction of the cataracts in 1936 the correction for the right eye was a + 11.00 sph. + 4.50 cyl. ax. 180°—, and that for the left, a + 11.00 sph. + 2.50 cyl. ax. 15°—.

On examination in 1935 the correction for the second patient, who had swollen lenses, was a + 8.00 sph. for the right eye and a + 8.50 sph. for the left.

After extraction of the cataract in 1936 the correction for the right eye was a + 13.00 sph. + 1.00 cyl. ax. 180°—, and that for the left, a + 8.50 sph. + 6.00 cyl. ax. 159°—.

These observations plainly show the early process of opacity of the lens due to di-nitrophenol in my three patients to be one of swelling and liquefaction and not of flattening or hardening.

DR. THURBER LE WIN, Buffalo: Ophthalmologists are indebted to Dr. Horner and his collaborators for the article on this subject in *The Journal* of last July. Shortly after reading it I saw this condition in a woman in her late thirties. It was baffling as to etiology. When questioned, she admitted that she had taken di-nitrophenol, having read of its effectiveness in reducing weight in the health column of a newspaper. Careful study showed no other reason for her cataracts, which were characterized by the fine powdery opacities under the anterior capsule and what I called a "surface of the moon" metallic appearance in the layers of the posterior capsule.

There were several points of interest in this case. The swelling lenses caused high tension with severe pains and nausea. It was necessary for me to do a basal iridectomy in each eye. Later the soft lenses were extracted. A second point of interest in this case were the postoperative refractive changes. On leaving the hospital the patient accepted a + 10.00 sph. ⊃ + 1.50 cyl. ax. 180 for one eye, giving vision of 20/20, and a month later a + 12.50 sph. ⊃ + 1.50 cyl. ax. 90 for the same eye gave the same result.

The blood chemistry was normal, and no marked differences in tension were apparent at the time. The same was true to a lesser extent of the other eye.

Has Dr. Horner had the same experience, especially as to the early high tension necessitating iridectomy?

I have seen another patient since who has not been operated on, and I believe that, despite warnings, ophthalmologists will see more patients with this condition. There still remains considerable di-nitrophenol on the drug shelves throughout the country, and there are many overweight young women anxious to reduce.

DR. OTTO BARKAN, San Francisco: In my experience, the striking point about the extraction of di-nitrophenol cataracts, which should be extracapsular, as Dr. Horner has pointed out, is the excellence of the results obtained. This is due, I believe, to the subcapsular position of the earlier opacification. For younger patients with cataract I have found a procedure which I reported in the February 1932 issue of the *American Journal of Ophthalmology* and which was further reported on by Dr. John Green. The results were gratifying, and I should like to call attention to this procedure again in connection with di-nitrophenol cataract.

MULTIPLE GOLD FOREIGN BODIES IN THE CORNEA

CLYDE E. McDANNALD, M.D.
NEW YORK

Introduction and embedding of foreign bodies in the substance of the cornea is a matter of every-day occurrence. The tolerance of the cornea to such insults depends in a great measure on the type of foreign body. Naturally, of metallic bodies, those offering the greatest resistance to oxidation are the least troublesome. The following case is reported as an illustration.

REPORT OF A CASE

The patient was brought to the New York Polyclinic Medical School and Hospital in an ambulance on March 3, 1926, with injuries to the face and eyes following an explosion.

He stated that he was an enameler of jewelry and that in the course of his occupation it was necessary to prepare a gold suspension. In doing so on the day preceding admission to the hospital he had boiled some 24 carat gold five minutes in nitrohydrochloric acid, a solution of two parts nitric acid and one part hydrochloric acid, commonly known as aqua regia. This was for the purpose of reducing the metal to a fine powder. When cooling had taken place, the gold was washed in a solution of household ammonia of about 60 per cent strength; this was followed by washing in warm water. The gold was then placed in a glass and allowed to dry overnight.

The next morning, while the patient was stirring the contents of the glass with a steel rod to break up some of the clumps, an explosion took place. A chemist informed me that a fulminate of gold had been created which when wet was harmless but when dry became explosive.

Physical examination revealed a dull brown discoloration of the forehead, lids, cheeks, nose and lips associated with swelling and redness. On the nasal side the conjunctivae were coated with a brown material, which was removed with difficulty. A multitude of fine particles of gold, extending practically over both the corneas, were embedded beneath Bowman's membrane and lodged also in the nasal portion of the conjunctivae. Roentgen examination for foreign body in the eyeball gave negative results. Vision was 20/70 in the right and 20/100 in the left eye.

Treatment consisted of curettage of the corneas, instillation of atropine sulfate and liquid petrolatum and application of a bandage. The curettage of the corneas failed to remove any appreciable number of foreign bodies, and as they were too numerous and it was too difficult to remove them with a pick that method was not used.

Presented before the Section of Ophthalmology of the New York Academy of Medicine, Nov. 18, 1935.

The patient left the hospital on March 10, 1926; at that time vision was 20/15 in each eye. Exfoliation of the epidermis had completely cleared the skin, and the patient was discharged on May 8, 1926. He was seen again on May 8, 1935, nine years later, and stated that during this time he had suffered no inconvenience or discomfort other than the fact that he had noted some decrease in visual acuity in his left eye, which was apparently due to roughening of the corneal epithelium caused by a forward movement of the particles of gold. Refraction after the administration of a cycloplegic showed that with a +0.50 sph. +0.50 cyl., axis 90°, vision was 20/15 in the right eye, and with a +0.25 sph. +0.25 cyl., axis 16° it was 2—/70 in the left eye.

Section of the cornea as seen under the slit lamp.

This case is reported because the condition seems to be unique and also because it demonstrates the tolerance of the corneal tissue to multiple foreign bodies of a nonoxidizing character.

DISCUSSION

DR. WENDELL P. HUGHES: This condition is extremely interesting because of its rarity. Reports of only two cases of gold wire penetrating the cornea could be found in the literature. In these cases the foreign body was removed from the cornea after two days and three

months, respectively. In both instances the piece of wire penetrated the anterior chamber, and the reaction cleared up quickly when it was removed. Several cases are reported in the literature in which marginal keratitis occurred during intravenous treatment of tuberculosis with various gold salts. In these cases the disorder healed quickly when the administration of the gold salt was discontinued. In most of them, however, no mention of gold deposits in the cornea was made. The nearest approach to the condition in Dr. McDannald's patient was described by O. Winkler Prins. He found gold deposits in the corneas of rabbits after treatment of experimental tuberculosis keratitis by instillation of sanocrysin (sodium gold sodium thiosulfate) into the eye and also after intravenous injection of the same gold salt. The gold deposits observed in the cornea were fine and were found on microscopic section to be mostly intracellular in the phagocytic cells adjacent to the walls of the blood vessels. As there are no blood vessels and no phagocytic cells in the portion of the cornea involved in the case reported by Dr. McDannald it is doubtful whether there has been much chemical change in the gold since it was originally forced into the corneal stroma in minute particles by the force of the explosion. The condition is also interesting because of the great number of particles and because of the fact that despite the length of time they have been present they have caused so little reaction. Finally, it is interesting to note the result in the left eye, where many particles of gold have worked forward to occupy a position just under the epithelium of the cornea, thus producing marked irregularity of the anterior surface and interfering with vision. This distortion of the anterior surface of the left cornea accounts for the loss of vision, and it is quite probable that vision would be improved by curettage of the epithelium and removal of the subepithelial particles of gold. The new epithelial surface would probably be less irregular than that which is present, and there would be a corresponding improvement in vision. Vision was normal in each eye for several years after the accident. It is probable that particles of gold in the left cornea migrated superficially as a result of an effort on the part of the cornea to extrude them.

OPERATION FOR RETENTION OF AN ARTIFICIAL EYE AFTER EXENTERATION OF THE ORBIT

ISADORE GOLDSTEIN, M.D.

NEW YORK

It was Bartisch [1] who introduced the medieval and Arlt [2] the modern method of exenteration of the orbit. To overcome this dreadful deformity, Axenfeld [3] suggested the operation in which the conjunctiva, lids

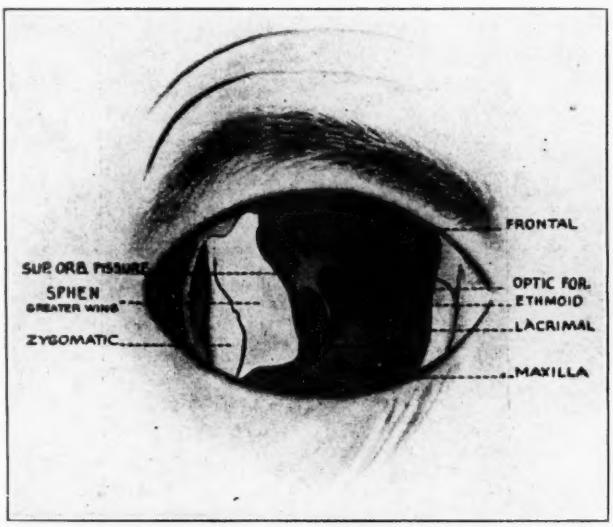


Fig. 1.—Appearance of the orbital cavity after exenteration.

and hair lines are preserved. Later the conjunctiva and lids are sutured. Other surgeons, Küster,[4] Busache,[5] Rollet,[6] G. Worms [7] and Romano-

This article was read before the Section on Ophthalmology of the New York Academy of Medicine on Dec. 16, 1935.

1. Bartisch, Georg: Ophthalmodouleia, Dresden, M. Stökel, 1583, chap. 3, p. 208.

2. Arlt: Operationslehre, in von Graefe, A., and Saemisch, E. T.: Handbuch der gesamten Augenheilkunde, ed. 1, Leipzig, Wilhelm Engelmann, 1874, vol. 111, p. 434.

3. Axenfeld: Ueber plastischen Verschluss der Orbita, Verhandl. d. Gesellsch. deutsch. Naturf. u. Aerzte **2**:301, 1904.

4. Küster: Die Deckung der Augenhöhle nach Ausräumung derselben, Centralbl. f. Chir. **17**:25, 1890.

(Footnotes continued on next page)

Catania,[8] used mucous membrane grafts, skin flaps, Thiersch grafts and sliding skin flaps to obviate the deformity without the introduction of a prosthesis. Few surgeons, however, have attempted to correct this deformity so that an artificial eye could be worn. Pólya[9] conceived the idea of introducing artificial bone into the orbital cavity and suturing the lids over it. In this manner a support is obtained for a prosthesis. Probably the best known procedure is the operation devised by Golovine,[10] in which a temporal pedicle flap is taken, passed through a vertical opening at the outer canthus, carried into the orbit and sutured in place to the surrounding structures.

I employed the following technic after exenteration of the orbit for a spindle cell sarcoma: The bony cavity (fig. 1) was previously lined

Fig. 2.—Aspect of the orbital cavity after exenteration when covered with a Thiersch graft.

by Thiersch grafts (fig. 2), and the remaining portions of the lids were placed within the orbit, where they became adherent to the bone. Six weeks later the adherent lids (fig. 3 *A*) were freed. This was

5. Busache: Come si debba coprire la cavità orbitaria dopo averla suturata, Riforma med. **4**:467, 1894.

6. Rollet: Occlusion de l'orbite et suppression des paupières, Rev. gén. d'opht. **27**:289 (July) 1908.

7. Worms, G.: Bull. Soc. d'opht. de Paris, June 1932, p. 358.

8. Romano-Catania, A.: Un nuovo processo di plastica per la copertura della cavità orbitaria nella exenteratio orbitae, Arch. di ottal. **1**:209, 1893.

9. Pólya, S. J.: Szemeszet, no. 4, 1904; abstr., Michel's Jahresb., 1904, p. 367.

10. Golovine: Procédé de clôture plastique de l'orbite après l'exentération, Arch. d'opht. **18**:679 (Nov.) 1898.

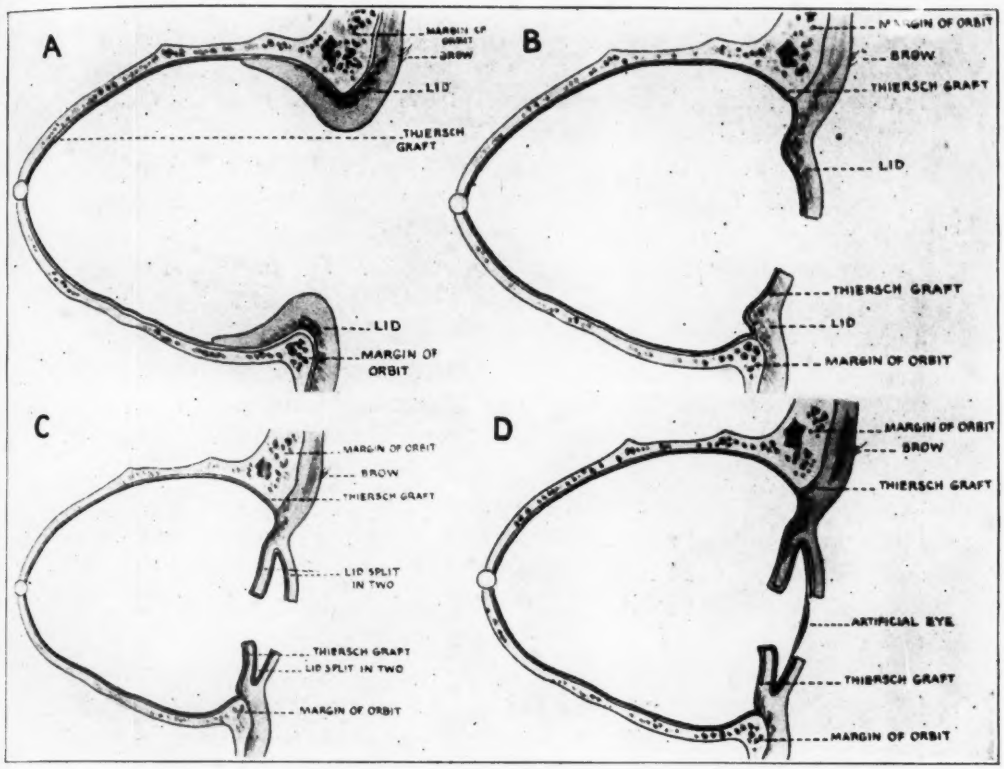


Fig. 3.—Sagittal sections of the orbit: A, the orbit lined with a Thiersch graft and the lids adherent to the bone; *B*, the orbit and the back of the lids covered by Thiersch grafts; *C*, Thiersch grafts covering the orbit, the posterior surface of the lids and the sulcus formed by splitting the lids; *D*, the Thiersch-lined sulcus formed by splitting the lids retaining the artificial eye.

Fig. 4.—Patient wearing the artificial eye.

readily done. Thiersch grafts were placed (fig. 3 *B*) on the denuded areas on the bone and on the back of the lids. The grafts were held in place by gauze packings. In this manner the upper and lower lids were partially restored. Three weeks later the lids were divided on their margins from the inner to the outer canthus, and the dissection was carried almost to the margins of the orbit. The horizontal division of the lids for their entire length gave the effect of four lids, two upper and two lower ones (fig. 3 *C*). Into the sulcus formed by separating the upper lid into two parts was placed a thin mold of Kerr's dental modeling compound. The mold was 1 mm. in thickness, 15 mm. in its vertical diameter and 50 mm. in its transverse diameter. The mold was covered by a Thiersch graft placed in the sulcus and kept in position by temporary sutures holding the two parts of the divided lid together. A similar mold covered by a Thiersch graft and placed in the sulcus of the divided lower lid was held in place by suturing the split lid. By placing a packing in the orbit and on the lids immobilization was obtained.

The plastic procedures described permit the formation of accessory lids which act as a diaphragm and in turn give support to the artificial eye (fig. 3 *D*). The hair lines were reconstructed following the method of Wheeler.[11] Destruction of the lashes is not advisable; they should be retained if this is feasible (fig. 4).

11. Wheeler: Restoration of the Margin and Neighboring Portion of the Eyelid by Free Graft from Lower Part of Eyebrow and Skin Directly Below It, J. A. M. A. **75**:1055 (Oct. 16) 1920.

PRIMARY ZONULAR OPACITY OF THE CORNEA

WILLIAM J. HARRISON, M.D.
PHILADELPHIA

The first case of zonular opacity of the cornea, reported by Dixon [1] in 1848, was an instance of the primary type. Since that time there have been reported numerous cases of the secondary type, which develops after some degenerative change in the eye. Comparatively few cases of the primary type have been reported.

REPORT OF A CASE

C. S., a hatter aged 58, complained that his vision was failing and that he suffered from severe headaches. The results of a careful physical examination were negative.

With the exception of the affected portion of the corneas, the anterior segment of each eye was normal. The vision in the right eye was 20/30, and in the left eye 20/40. With glasses, it improved to 20/20 in the right eye and to 20/30 in the left eye. The field of vision and the ocular tension were normal.

With the slit lamp the right eye showed a leaden gray corneal opacity which extended to within 2 mm. of the limbus temporally and 2 mm. from the limbus nasally, was slightly above the center of the pupil and extended below to within 6 mm. of the limbus. The depth of the anterior chamber was 1.9 mm. Roughly, the opacity resembled a crescent with the greater curvature below. It was situated on the anterior surface of Bowman's membrane. At no point did it seem to invade the epithelium. There seemed to be some extension of the opacity into the substantia propria, but apparently it did not reach as far back as Descemet's membrane. In addition, there were noted several small clear spaces in the center of the opacity which gave a black reflex (Koby [2]). In the clear part of the cornea above the opacity there were noted many corneal nerves. The lens, as viewed through the clear part of the cornea above the opacity, was normal. The left eye showed a similar condition. The eyegrounds were normal. (Koby [2] discussed these round holes and considered them diagnostic of the condition.) There was lowered sensibility of the corneas which seemed to be solely over the affected part.

Rabbit pelts are used in the manufacture of felt hats, and it was my patient's duty to operate a machine which separated the hair from the fur. This was accomplished by means of a blower containing mercury vapor, which, passing through a tube, separated the hair from the fur. The eyes and noses of the workers seemed to be most affected. Continual use of a handkerchief was essential. It was customary for the workers to have one week's vacation each month, in which they were advised to stay outdoors as much as possible. The average stay of a man who worked in this department was three years; my

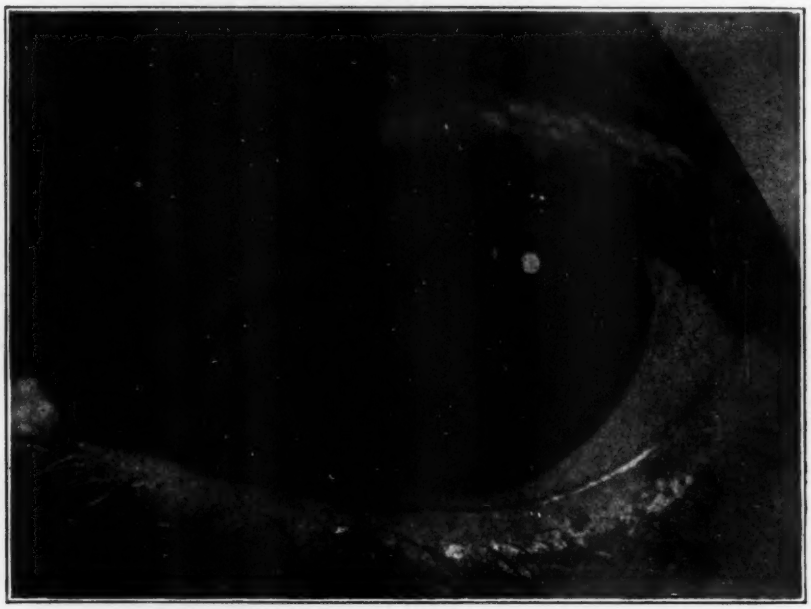
1. Dixon, J.: Diseases of the Eye, ed. 1, London, J. Churchill, 1848, p. 114.

2. Koby, F.: Slit-Lamp Microscopy of the Living Eye, translated by Charles Goulden and Clara Lomas Harris, Philadelphia, P. Blakiston's Son & Co., 1930, p. 151.

patient had worked in this department for thirteen years. It is difficult to say when the opacity first began, since it was only in the past several years that the patient had been aware of any interference with his vision. This interference was most noticeable for close work.

ETIOLOGY

The etiology of the primary form of zonular opacity of the cornea has not been thoroughly investigated. Duane [3] stated: "There is a disturbance of nutrition caused by a lessened ability of the cornea to withstand repeated external injuries or influences." According to Leber,[4] one of the injurious influences that invades the palpebral region of the cornea is evaporation of the nutrient fluid of the cornea. This fluid is



Photograph of the left eye. In the preparation of the photograph a Leica camera, model F, with a F.2 lens and a lens diaphragm F 6.3, 1/8 second, was used, with a sliding focusing copy attachment with a 6 cm. extension tube. An Eastman panatomic film was employed and illuminated by the use of a Zeiss hammer lamp, the work being carried out by Street, Linder and Propert, opticians, Philadelphia.

supposed to be richer in lime salts, which are precipitated under the influences of evaporation. This, however, was believed to be due in part to a gouty or rheumatic diathesis, and the earlier writers endeavored to link this condition with gout or rheumatism. Improper closure of the lids during sleep may have a bearing on the formation of the

3. Duane, A., quoted by Fuchs, E.: Textbook of Ophthalmology, translated by Alexander Duane, ed. 7, Philadelphia, J. B. Lippincott Company, 1923, p. 587.

4. Leber, quoted by Fuchs, E.: Textbook of Ophthalmology, translated by Alexander Duane, ed. 7, Philadelphia, J. B. Lippincott Company, 1923, p. 588.

opacification, but close observation of the patient whose case is reported here showed the lids to be normally closed during sleep.

According to Hansell,[5] the primary form is associated with or follows glaucoma. Von Graefe[6] believed that a primary form was likewise attributable to a glaucomatous process, eventually resulting in glaucoma. While the tension in the case reported here was a high normal, there were no other prodromal signs or symptoms to substantiate the diagnosis of even a preglaucomatous condition.

My case parallels the cases reported by Topolanski[7] and by Clarke.[8] Topolanski's patient was a hatter who worked in a room where the air was impregnated with fine particles of hair and fur, while Fairlie Clarke's patient was a water gilder who had been in the habit of working over a hot fire, melting gold and mercury together, and the mercury fumes were given off so freely that there was a fine deposit of mercury on his face. The patient in case 14 of Nettleship's[9] series, a barometer maker, admitted, however, having little to do with mercury. In further support of mercury as an etiologic factor is a case reported by Fuchs,[10] that of a physician who blew mild mercurous chloride into his eyes daily.

TREATMENT

Little has been said concerning the treatment for the primary form of ocular opacity of the cornea. According to François,[11] the secondary form has been treated with acetic acid, nitric acid, hydrogen, a solution of potassium hydroxide, roentgen irradiation and a solution of tartaric acid by the following investigators: Beyser, Galezowski, Nettleship, Sellerbeck and Zur Nedden. He[11] also stated in the same article that Von Graefe and Landenberg employed optical iridectomy and that curettement of the affected area had been advised by Beselin, Bernbacher, Bowman, Dixon, Koster, Shellen, Sommner and Stein. For the present no treatment has been advised for my patient.

135 South Seventeenth Street

5. Hansell, H. F., and Sweet, W. M.: Text-Book of Diseases of the Eye, Philadelphia, P. Blakiston's Son & Co., 1903, p. 227.

6. von Graefe, A.: Band Keratitis Considered in Relation to Glaucoma, Ophth. Hosp. Rep. **7**:1, 1869.

7. Topolanski: Die Etiologie der Bandformigen Hornhauttrubung, Wien. klin. Wchnschr. **7**:98, 1894.

8. Clarke, W. F.: On Some Rare Forms of Opacity of the Cornea, Brit. M. J. **2**:380, 1870.

9. Nettleship, E.: On a Rare Form of Primary Opacity (Transverse Calcareous Film) of the Cornea, Arch. Ophth. **8**:293, 1879-1880.

10. Fuchs, E.: Textbook of Ophthalmology, translated by Alexander Duane, ed. 7, Philadelphia, J. B. Lippincott Company, 1923, p. 587.

11. François, J.: Band Keratitis and Its Treatment, Bull. Soc. d'opht. de Paris, December 1934, p. 636.

FIBROSARCOMA OF EYELID

REPORT OF A CASE

A. LLOYD MORGAN, M.B.

TORONTO, CANADA

Various textbooks of pathology [1] state that a spindle cell sarcoma may originate in almost any situation in which there is connective tissue, such as the subcutaneous and submucous tissues, fasciae, muscles, periosteum and framework of organs. Fuchs [2] mentioned fibroma as among the very rare tumors of the lids. Therefore, it is thought that this case might prove of interest for two reasons: first, because of the unique location of the tumor and, second, because in the early stages the growth simulated chronic conjunctivitis and blepharitis.

REPORT OF CASE

History.—B. D., a boy aged 9 years, was admitted to the Hospital for Sick Children, with the complaint that three months before admission his right lower lid began to swell and redden. There had been no previous injury or inflammation. The family physician treated the condition as conjunctivitis, and when no improvement was noted he scraped some of the conjunctiva and sent the tissue to the department of health of Ontario. These scrapings showed marked chronic inflammation and edema, the infiltrating cells being chiefly lymphocytes with a few endothelial cells. The diagnosis was subacute conjunctivitis, with no evidence of malignancy.

After removal of the tissue the lid rapidly increased in size. When the patient was admitted to the hospital on Dec. 21, 1933, the right lower eyelid appeared brownish and markedly swollen, and the lashes grew irregularly. The swelling involved the whole lid and extended beyond the inner and the outer canthus into the upper lid (fig. 1). Palpation revealed that the swelling was caused by a firm mass which involved the margin of the lid but was not attached to the border of the orbit or to the skin on the anterior surface. When the upper lid was everted, thick yellow folds of conjunctiva protruded, and this suggested that the process

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Read before the Section of Ophthalmology, Academy of Medicine, Toronto, Canada, Jan. 13, 1936.

From the Department of Ophthalmology, University of Toronto, and the Hospital for Sick Children.

1. (*a*) MacCallum, W. G.: A Text-Book of Pathology, ed. 4, Philadelphia, W. B. Saunders Company, 1928. (*b*) Delafield, F., and Prudden, T. M.: Text-Book of Pathologic Anatomy and Histology, ed. 8, New York, William Wood & Company, 1909. (*c*) Boyd, William: Surgical Pathology, ed. 2, Philadelphia, W. B. Saunders Company, 1929.

2. Fuchs, E.: Text-Book of Ophthalmology, translated by A. Duane, ed. 8, Philadelphia, J. B. Lippincott Company, 1934.

was invading the region. The eyeball, cornea, iris, fundus and ocular movements were normal in both eyes. With the exception of the mass on the right lid, the results of physical examination were negative. The Wassermann reaction of the blood was negative.

About two weeks after admission, with the boy under general anesthesia, a biopsy specimen 1 cm. long was removed from the center of the mass on the right lower lid.

Pathologic Report (Dr. I. H. Erb).—The gross specimen consisted of a small piece of grayish-pink, moderately firm tissue, measuring 1 cm. in its greatest diameter. There was a small amount of hemorrhage. Microscopically, the material consisted essentially of a loose, somewhat edematous mass of round, oval and spindle-shaped cells which showed marked variation in size. The majority of these cells presented a bluish, hazy appearance, the chromatin showing up very poorly. Among these cells could be seen a number of mitotic figures, the majority of which

Fig. 1.—Appearance of lid three months after the onset of the symptoms.

had not yet divided. Toward one side of the section there was what appeared to be a portion of a nerve, the cells of which were irregular in their arrangement at one place. Scattered throughout the tissue were a number of small round cells. Vessels were not very plentiful. A diagnosis of sarcoma was made.

After biopsy the tumor began to increase so rapidly in size that it was deemed advisable to attempt its removal. This was done on Jan. 16, 1934, with the patient under general anesthesia. An incision was made in the skin about 1 cm. from the margin of the lid and parallel to it. The skin was dissected down toward the cheek along the anterior surface of the tumor, and the conjunctiva was freed from the posterior surface. It was then seen that the mass involved the inner and the outer canthus to such an extent as to make impossible complete removal of the tumor. As much tissue as could be taken without leaving the eyeball unprotected was dissected out, and the skin and conjunctiva were sewn together.

Again, because of the nature of the tumor, the pathologic report is given in detail. The gross specimen consisted of the cutaneous margin of the right lower

eyelid attached to a flattened ovoid mass, measuring in all 4 by 2.5 by 1 cm. The margin of the lid appeared edematous; the hairs on it were few in number. The tissue forming the mass had an elastic feel and on one surface seemed to have a thin capsule; on the other surface this was not apparent. On section, the tissue showed irregular large lobulations, and the substance appeared pale yellowish pink and somewhat translucent. To one side of the mass was soft pinkish tissue, apparently not involved by this new tissue. Microscopically, the section showed stratified squamous epithelium on one side, with considerable keratin. Just under this there were numerous large hair follicles, sebaceous glands and a considerable amount of connective tissue. The deeper part of the section was almost entirely composed of tumor tissue. The tumor cells had oval or round nuclei and little or no cytoplasm (fig. 2). Numerous mitotic figures were seen. There was con-

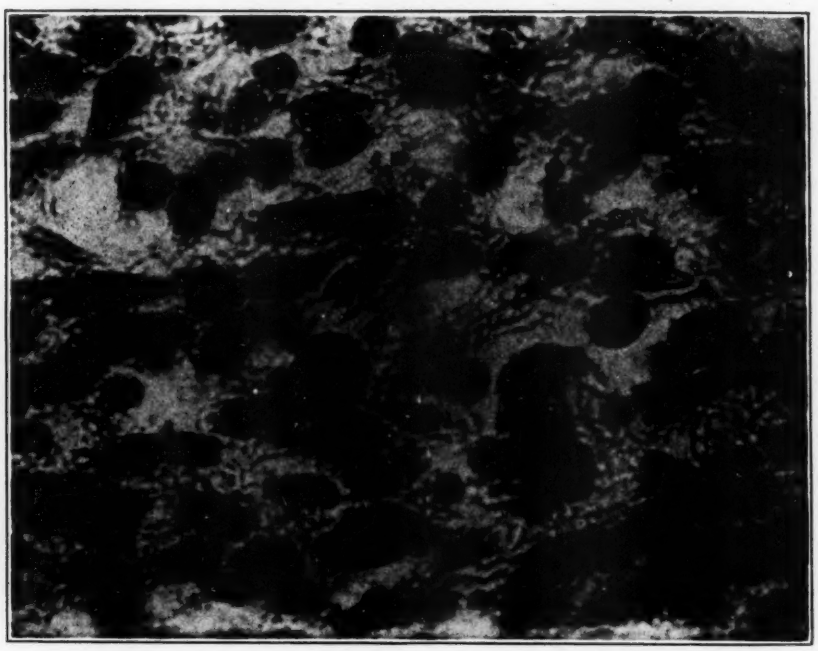

Fig. 2.—Tissue from the lower lid, showing spindle-shaped cells. Hematoxylin-eosin stain; × 800.

siderable variation in size, shape and staining properties of the tumor cells. The intercellular tissue was edematous and contained many pink-staining fibrils. Tumor cells could be seen invading the subcutaneous tissue and skin itself. Around the papillae the cells took on a more fusiform shape. In the section stained with phosphotungstic acid and hematoxylin the stroma of the tumor tissue showed many fibrils, and in the preparation stained by the Van Gieson method many of these fibrils appeared pink.

The sections were submitted to several pathologists for diagnosis and the following diagnoses were given: (1) fibrosarcoma, (2) fibromyxosarcoma and (3) sarcoma, type undetermined.

A complete physical examination of the patient at this time revealed no evidence of metastases. As it was impossible to remove all of the tumor, it was

decided to sacrifice the eye. An exenteration of the orbit was performed on January 25. This was followed by radium treatment, 90 mg. for twenty-four hours, on February 15, and 80 mg. for twenty-four hours on June 2.

The boy was last seen in January 1936, two years after the orbital exenteration. The orbit showed typical roentgen scarring. There was no evidence of local recurrence, and the general physical examination as well as roentgenograms of the chest did not reveal any metastases.

COMMENT

The diagnosis in this case was difficult both clinically and pathologically. In the early stages the process resembled blepharitis and conjunctivitis, and the lid was only slightly swollen. However, the rapid growth suggested a neoplasm. Sections taken at this time were not interpreted as those of a neoplasm, possibly because the conjunctival scrapings were too superficial, and, as Boyd [3] stated:

> The histological diagnosis of sarcoma may be one of the most difficult tasks in pathology. A typical sarcoma may be recognized at a glance, but there are numberless gradations toward innocent connective tissue growths which may make differentiation very hard. To complicate the problem still further simple inflammatory tissue, especially when undergoing repair, may bear so close a resemblance to certain forms of sarcoma as to deceive the very elect.

The later biopsy specimen, which passed completely through the tumor, showed definitely a rapidly growing connective tissue type of neoplasm.

The radical treatment in this case may be questioned. This type of tumor is usually slow in growth, recurs many times after removal and only after several extirpations shows more primitive and malignant cell forms. However, in this instance the growth progressed rapidly while the boy was under observation and was early clinically malignant. This was confirmed by the biopsy three months after the onset of the symptoms.

SUMMARY

A case of fibrosarcoma of the eyelid in a 9 year old boy has been presented. There has been no regional recurrence or metastasis twenty-four months after removal of the tumor and orbital contents.

3. Boyd,[1c] p. 183.

EFFECT OF INTRA-OCULAR CONCENTRATION OF TYPHOID ANTIBODIES ON EXPERIMENTAL CORNEAL ULCERS

WITH A REPORT OF SEVEN CASES

ALBERT LOUIS BROWN, M.D.

AND

JANET PUGH, B.A.

CINCINNATI

The parenteral administration of various proteins for their nonspecific action on ocular inflammations is an accepted procedure. There have been many opinions expressed concerning the mode of action of this form of therapy. The consensus seems to emphasize a rise in the body temperature, which is considered to be well above the optimum for various organisms. Leukocytosis, which usually accompanies such therapy, is supposed to be beneficial and to indicate an increase in the general body defense. The other factors, such as an increase in the complement and antibody content of the blood, are grouped under the vague term "increased general resistance." Suffice it to say that the mechanism of the action of nonspecific therapy is not understood. So far as the eye is concerned, the rise in temperature could not benefit inflammations of the uveal tract by killing organisms, for the intra-ocular contents in a case of nonspecific uveitis rarely, if ever, give positive cultures except in obvious metastatic infection which usually ends in panophthalmitis.[1] Even if it is assumed that the toxin carried to the eye is responsible for the disorder, it is inconceivable that the organisms or their products could be rendered ineffective so quickly, for acute iritis often responds to one intravenous injection of typhoid vaccine within from thirty-six to forty-eight hours. Though the organisms themselves might be attenuated or even killed in the presence of a temperature of from 103 to 104 F., the residual toxins still circulating would require a much higher temperature to alter their irritating or sensitizing qualities.[2] Leukocytosis in which the white cell count is from 15,000 to 20,000 is probably not sufficient to combat any large local focus but

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1. Brown, A. L.: Chronic Uveitis: Bacteriologic and Immunologic Considerations, Arch. Ophth. **12**:730 (Nov.) 1934.

2. Brown, A. L.: Am. J. Ophth. **15**:19, 1932.

is possibly an indication of a general reaction against the foreign protein. If the leukocytosis were so important in the uveal tract it would probably be just as effective alone, because on section the uvea, especially in a case of chronic uveitis, presents great leukocytic infiltration. Thus, one comes to a consideration of the antibodies which most proteins produce in the blood on parenteral injection. It seemed [3] possible that the intra-ocular presence of these antibodies derived from the blood might account for the local ocular reaction. The Saemisch section, delimiting keratotomy,[4] and Schieck's [5] injection of blood into the anterior chamber in cases of tuberculous uveitis are considered to depend in great part on an increase in the normal antibodies in the eye for their beneficial effects.

Protein antibodies are mostly specific for the antigen injected, but there is abundant proof that they have nonspecific properties as well. Among other investigators, Prausnitz and Meissner [6] recorded a rapid increase in the bactericidal power of whole blood after the injection of sodium iodoxyquinoline sulfate and of a preparation of sterile milk. Nukada and Arifuku [7] showed that suspensions of killed pneumococci and plague bacilli injected subcutaneously in three doses at five day intervals into guinea-pigs produced increased resistance to the typhoid bacillus, which was evidenced by delay of death beyond the occurrence of death in the controls. Similarly, it was considered that the effects of proteins parenterally administered in ocular therapy may depend in part on the nonspecific properties of the antibodies carried to the eye. In this investigation of the effect of the intra-ocular antibody content on corneal ulcers, typhoid vaccine was chosen because it produces typical protein reactions and an easily measurable antibody content and is a popular agent. This protein when administered intravenously in sufficient amount causes a rapid rise in the temperature, usually to from 101 to 103 F., within from eight to twelve hours, an average count of 15,000 leukocytes and definite antibody formation in the blood. Typhoid antibodies appear in the blood in small quantities (a titer of from 1:5 to 1:20) within from twenty-four to forty-eight hours after the intravenous injection of a suspension of 10,000,000 killed organisms. The titer rises from this time onward, and if no subsequent dose is given it reaches its height on about the sixteenth day. It then falls, at first rapidly and then slowly, agglutinins still being present one hundred days after inoculation. If too large a second dose is given, there may follow

3. Brown, A. L.: Tr. Am. Ophth. Soc. **33**:435, 1935.
4. Gradle, H. S., and Gifford, S. R.: Am. J. Ophth. **17**:602 (July) 1934.
5. Schieck, F.: Ber. ü. d. Versamml. d. deutsch. ophth. Gesellsch. **49**:183, 1932.
6. Prausnitz, C., and Meissner, G.: Zentralbl. f. Bakt. **94**:376, 1925.
7. Nukada, S., and Arifuku, S.: Ztschr. f. Immunitätsforsch. u. exper. Therap. **70**:1, 1931.

shock, a rise in temperature and leukocytosis, but the titer rises to a low level and sinks (negative phase) and then rises again over a varying period. However, after a moderate dose has been administered to cause the initial rise, the condition of the patient permitting, another similar dose will augment the rise in titer so that a succession of injections will, within limits, cause an early, appreciable concentration of the antibodies of the blood of from 1:600 to 1:1,000+. If an injection is given during the negative phase, shock and a depression of the concentration result. Although proper injections produce a considerable concentration of antibodies in the blood, the ocular vessels in a normal eye seem impermeable to the agglutinins, and a relatively low titer of the aqueous (1:2 or less) persists. It seemed that if the antibodies within the eye had any local therapeutic effect, either small quantities of antibodies were potent or local inflammation tended to raise the titer. Both conjectures were found to be true, but the latter factor was the more important, as was observed in experiments previously reported.[3] Animals inoculated with vaccine were subjected to uveal sensitization produced by the intra-ocular injection of killed streptococci. The uveal inflammation resulting after activation by the intravenous injection of the streptococci was accompanied by a rise of the typhoid antibody titer in the aqueous. If the titer rose to 1:16+, interference with the continuance of uveal inflammation occurred, and the eye cleared. If the titer of the aqueous was raised before the sensitizing dose was administered, later activation was inhibited. The titer of the aqueous was increased by causing a more rapid secretion of aqueous by aspiration of the anterior chamber. The administration of typhoid vaccine without definitely raising the titer of the aqueous was slightly effective in curtailing the ocular reaction, but this was never comparable to the effect of high intra-ocular concentration. It appeared likely that the case for the action of intra-ocular antibodies could be strengthened if an "interference" effect could be demonstrated on corneal ulcers, especially since the cornea is avascular and in direct contact with the aqueous.

Attempts to evaluate experimentally the effect of nonspecific protein on ocular infection have been reported. Scarlett[8] attempted to determine the effects of erysipelas and prodigiosus toxins and of diphtheria antitoxin after the inoculation of suspensions of pneumococci and staphylococci into the anterior chambers of rabbits. He felt that if the animals were not overwhelmed by the virulence of the infection the condition was improved by the administration of these proteins. Key[9] attempted to standardize a dosage of staphylococci which would produce

8. Scarlett, H. W.: Am. J. Ophth. **10**:747, 1927.

9. Key, B. W.: Am. J. Ophth. **9**:351, 1925.

a given lesion in the cornea. He was unable to produce a standard lesion with different strains and different animals. However, he found that those animals which received foreign proteins showed less corneal reaction to invading organisms than did the controls. Diphtheria antitoxin seemed to be most effective and milk the least effective.

PRODUCTION OF CORNEAL ULCERS

It is easy to understand the difficulties of my predecessors in attempting to produce a standardized corneal ulcer. Most strains of Streptococcus and some strains of Pneumococcus overwhelmed the cornea in rabbits, perforated it and produced panophthalmitis within four or five days following intracorneal injection. Many strains of Staphylococcus produced either a thick, purulent macerated débris in a few days or nothing. After many attempts with various strains of Staphylococcus and different suspensions of a strain which seemed promising, a suspension of living organisms was found which produced a fairly uniform lesion when ½ minim (0.03 cc.) was injected into the upper layers of the stroma. The ulcer attained a diameter of about 1 mm. and was circumscribed and slightly elevated in twelve hours. It progressed slowly and became deep but did not perforate. After twenty-four hours the infected area widened slowly and advanced laterally, and when the outer surface began to disintegrate there appeared a small, ragged "shelf" not unlike that of an advancing serpiginous ulcer. In from twelve to sixteen days the ulcer resolved into a dense scar involving from one-third to one-half the corneal surface and extending well into the stroma. An ulcer could be produced only by intracorneal injection, and not by instillation, even in the presence of small, superficial corneal abrasions.

EFFECT OF INTRA-OCULAR TYPHOID ANTIBODY CONTENT

A series of rabbits were immunized with typhoid vaccine until the average titer of the blood was 1:1,000+. The same number of unimmunized animals were reserved as controls. The immunized rabbits will be designated as T animals and the controls as C animals.

Both corneas of each animal were inoculated with ½ minim (0.03 cc.) of the suspension of living staphylococci. Previous experiments [3] have shown that aspiration of aqueous increases the titer of typhoid antibodies in the aqueous in the presence of concentration of antibodies in the blood of 1:16+. Aqueous of the anterior chamber of the right eye of each animal was aspirated to note the effect of the concentration of antibodies in the aqueous on the ulcer in the right eye as compared with the ulcer in the left eye, on which aspiration was not carried out. Thus it was possible to study the effect of different intra-ocular concentrations of typhoid antibodies raised at different intervals of time to various levels. Individual differences in reactions to the organism could be fairly well discounted because of the comparative reactions in the two eyes of the same animal. The effect of aspirating aqueous of the right eye in the control animals

was compared with that attained in the immunized animals and in the left eyes of the controls, on which aspiration was not carried out.

T_1 and C_1 Animals.—Aqueous of the right eyes of seven immunized and seven control rabbits was aspirated immediately after corneal inoculation with the

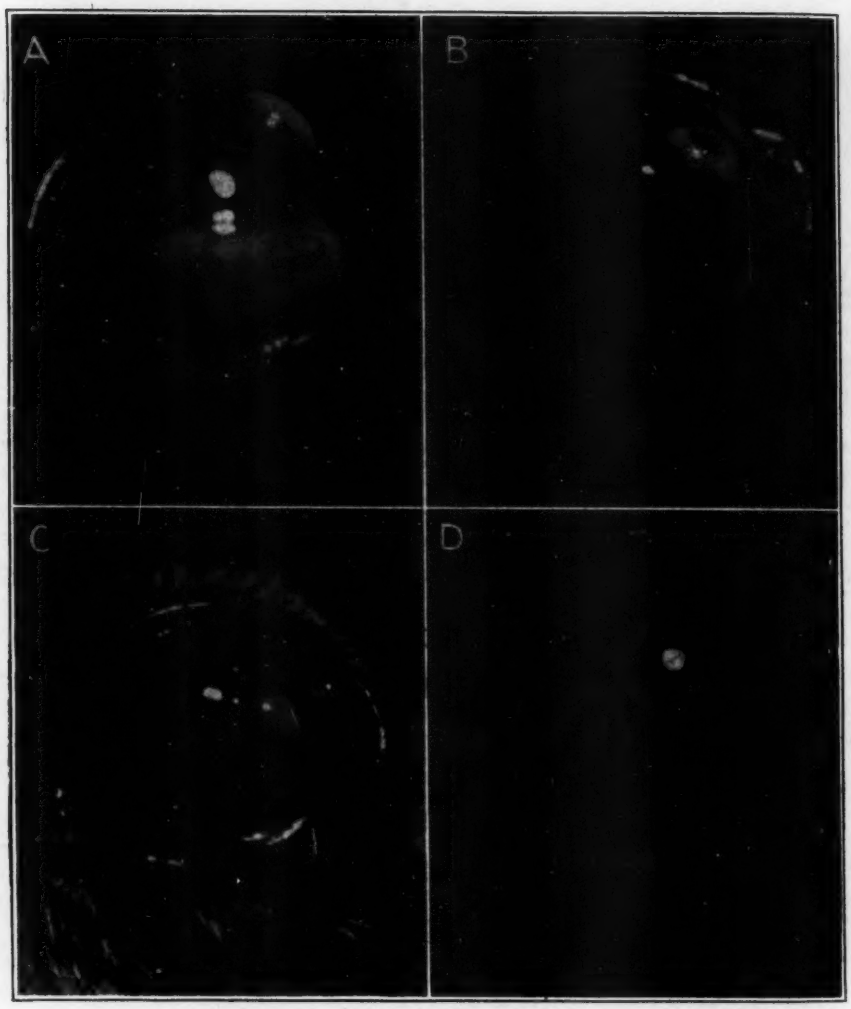

Fig. 1.—Photographs showing an untreated corneal ulcer produced by intracorneal injection of a suspension of staphylococci, from the acute stage to the scar. *A* shows the ulcer thirty-six hours after injection of the suspension of staphylococci; *B* is a front view of the ulcer thirty-six hours after the injection; *C* shows the ulcer receding seventy-two hours after inoculation, and *D* shows the corneal scar seven days after inoculation.

suspension of staphylococci. Within twenty-four hours no lesions were visible in the right corneas of five of the T_1 animals. A small ulcer the size of a pinpoint appeared in the right cornea of each of the other T_1 animals. The left corneas

of all the T_1 animals had ulcers 2 mm. in diameter. The corneas of the T_1 animals presented ulcers 2.5 mm. in diameter, but the ulcers in the right eyes were not as elevated as those in the left. In forty-eight hours the small ulcers in the right eyes of the T_1 animals had disappeared, leaving no trace. The ulcers in the left eyes remained rather stationary for about seventy-two hours and

Fig. 2.—Photographs of the corneas of both eyes of the same rabbit after inoculation with suspension of staphylococci. The animal was previously immunized with typhoid vaccine. *A*, view of the right eye twenty-four hours after inoculation. No lesion occurred. Aqueous was aspirated before corneal inoculation. *B*, view of the left eye (control) twenty-four hours after inoculation, showing an ulcer.

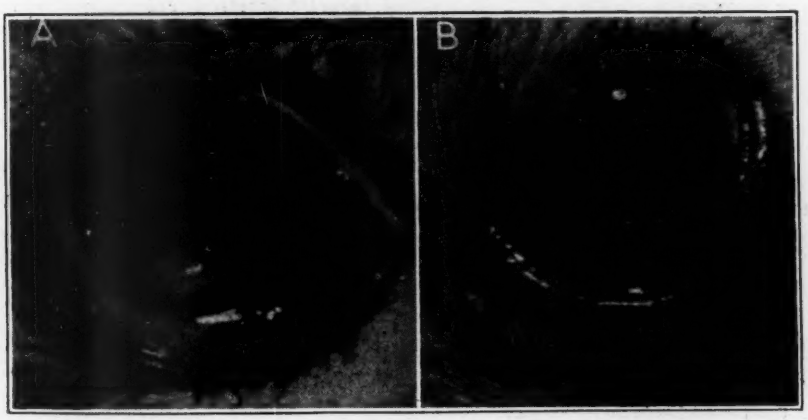

Fig. 3.—Photographs of corneal ulcers in both eyes of an animal immunized with typhoid vaccine, twenty-four hours after inoculation with a suspension of staphylococci. *A* shows the corneal ulcer in the left eye, from which aqueous was not aspirated. *B* shows the ulcer in the right eye twenty-four hours after inoculation. Aqueous was aspirated immediately after inoculation.

gradually resolved, each leaving a dense scar 2 mm. in diameter. The ulcers in the eyes of the C_1 animals progressed, those in the left eyes more rapidly than those in the right. Aspiration of aqueous from the right corneas of the controls

definitely inhibited the ulcers' advance and effected an earlier resolution and a smaller scar than occurred in the case of the ulcers in the left corneas.

The next group of animals, designated T_2 and C_2, were treated as the first group, except that the first aspiration of aqueous from the right cornea was done twenty-four hours after corneal inoculation. At this twenty-four hour period all the corneas showed well developed ulcers. Those in the immunized animals seemed slightly smaller and less raised than those in the controls. Twenty-four hours after aspiration of aqueous from the right corneas there was a marked difference between the ulcers in the right eyes of the T_2 animals and those in the right eyes of the C_2 animals. Beginning at this time, aqueous from the right cornea was aspirated thereafter at twenty-four hour intervals. Forty-eight hours after corneal inoculation the ulcers in the right eyes of the T_2 animals were an average of 1.5 mm. in diameter and were slightly elevated. The ulcers in the left eyes were 2 mm. or more in diameter and were definitely elevated. At this time the ulcers in the right eyes of the C_2 animals had progressed to about 3 mm. in diameter; they seemed slightly smaller and less elevated than the ulcers in the left eyes but were as dense. At the end of the seventy-two hour period the ulcers in the right eyes of the T_2 animals had resolved to 1 mm. in diameter, were flat and did not stain with fluorescein. Those in the left eyes stained, were elevated and were 2 mm. in diameter. In ninety-six hours the ulcers in the right eyes of the T_2 animals had resolved to tiny faint scars that were mere superficial dots. The ulcers in the left eyes still stained but finally quieted to scars 2 mm. in diameter involving the superficial tissues and reaching into the upper part of the stroma. The ulcers in the eyes of the C_2 animals resolved more slowly. At the end of the ninety-six hour period there was little difference between the ulcers in the right eyes and those in the left eyes. They were still active in one hundred and sixty-eight hours and produced dense scars from 3.5 to 4 mm. in diameter in two hundred and forty hours.

The next group of animals (T_3 and C_3) were treated as those in the preceding groups, except that the initial aspiration of aqueous from the right cornea was not done until forty-eight hours after corneal inoculation. These results are summarized in table 1 to avoid extensive protocols.

The findings may be divided into four groups: 1. The ulcers produced in immunized animals advanced less rapidly, showed less increase in size and left smaller and fainter scars than those in the controls. 2. Aspiration of aqueous from the corneas of the immunized animals immediately after introduction of the organisms prevented or greatly reduced infection, whereas ulcers in the untreated corneas became firmly established. 3. Aspiration of aqueous from the right corneas of the control animals definitely inhibited the advance of the ulcer, as compared to the ulcers in the corneas of the controls on which aspiration was not carried out. 4. The ulcers in the corneas of the immunized animals on which aspiration was carried out did not, as a rule, become as large or cause as much corneal destruction as those in either of the eyes of the controls. However, the former were well established and did not recede any sooner than those in the eyes of the controls on which aspiration was carried out. Those in the eyes of the controls on which aspiration was not carried out advanced more rapidly, became larger and caused more corneal destruction, leaving larger and deeper scars.

PRODUCTION OF INTRA-OCULAR ANTIBODIES BY DIRECT OCULAR INJECTION OF TYPHOID VACCINE; EFFECT ON CORNEAL ULCERS

Although a definite site of antibody formation is not known, it has been observed that organs into which an antigen is directly injected are higher in antibody content than other organs. The concentration of antibodies of the blood soon rises as a result of any parenteral injection of typhoid vaccine, but if the eye is the site of the injection the tissue of this organ becomes rich in antibodies.[10] Thus it was possible to raise the intra-ocular antibody content by injection into the anterior chamber, thereby eliminating protein shock and leukocytosis, two factors commonly considered to be associated with the beneficial action of non-specific therapy. The concentration of intra-ocular antibodies was there-

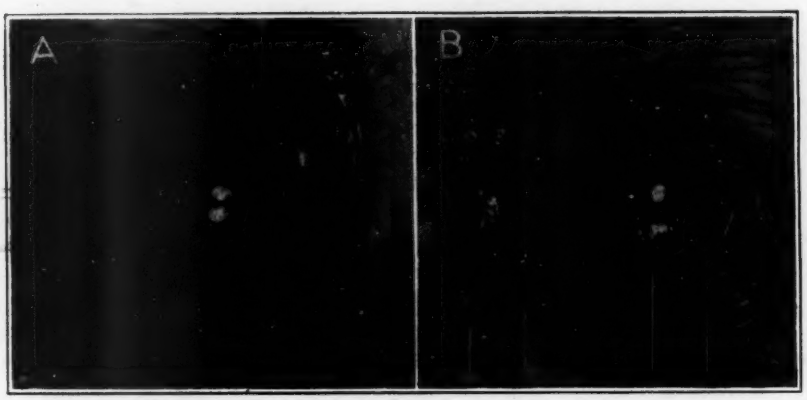

Fig. 4.—Photographs of eyes of an animal given an injection of typhoid vaccine into the anterior chamber of the right eye forty-eight hours before corneal inoculation with a suspension of staphylococci. *A*, view of the right eye, showing ulcer which appeared forty-eight hours after corneal inoculation. *B*, view of the left eye (control) of the same animal forty-eight hours after corneal inoculation.

fore the prime factor in one eye of an animal, for the fellow eye into which no injection was made could be used as a control. It seemed reasonable to assume that if the local antibody content were raised by direct injection into one eye, without any general rise in temperature or increase in the leukocyte count, any local effect on organisms injected into the cornea must be due to the presence of the intra-ocular antibodies and not to any systemic reaction.

Five rabbits were given one injection of 2 minims of a fairly heavy suspension of dead typhoid bacilli into the right anterior chamber. Six days later 1½ minims

10. Seegal, B. C., and Seegal, D.: Proc. Soc. Exper. Biol. & Med. **31**:437 (Jan.) 1934.

TABLE 1.—*Comparison of Ulcers in Immunized and in Control Animals*

Rabbits*	Description of Corneal Ulcers after Inoculation of ½ Minim of Suspension of Staphylococcust	Time of Aspiration of Aqueous After Corneal Inoculation	Antibody Titer of Aqueous	Antibody Titer of Blood Serum
T_1	**Right cornea**			
	0 hr.: no lesion	Immediately after	1:2	1:1,000+
	24 hr.: no lesion	24 hr. after	1:16	1:1,000+
	Left cornea			
	24 hr.: 2 mm.; slightly elevated	Not aspirated		
	48 hr.: 2.5 mm.; slightly elevated			
	96 hr.: 2 mm.; dense scar			
C_1	**Right cornea**			
	0 hr.: no lesion	Immediately after	0	0
	24 hr.: 2.5 mm.; slightly elevated	24 hr. after	0	0
	48 hr.: 2 mm.; stains	48 hr. after	0	0
	86 hr.: 2.5 mm.; edges ragged	72 hr. after	0	0
	168 hr.: 2 mm.; dense scar			
	Left cornea			
	24 hr.: 2.5 mm.; elevated	Not aspirated		
	48 hr.: 2.5 mm.; stains			
	72 hr.: 3 mm.; edges ragged; advancing			
	96 hr.: 3.5 mm.			
	168 hr.: 4 mm.; dense scar			
T_2	**Right cornea**			
	24 hr.: 2 mm.; slightly elevated	24 hr. after	1:2	1:1,000+
	48 hr.: 1.5 mm.; slightly elevated	48 hr. after	1:18+	1:1,000+
	72 hr.: 1 mm.; flat	72 hr. after	1:36	1:1.000+
	96 hr.: small superficial dot	96 hr. after	1:40+	1:1,000+
	Left cornea			
	24 hr.: 2.5 mm.; elevated	Not aspirated		
	48 hr.: 2.5 mm.; elevated			
	72 hr.: 2 mm.; stains; slight breaking down			
	96 hr.: 2 mm.; stains			
	120 hr.: 2 mm.; faint scar			
C_2	**Right cornea**			
	24 hr.: 2.5 mm.; elevated	24 hr.	0	0
	48 hr.: 2.5 mm.; elevated	48 hr.	0	0
	72 hr.: 3 mm.; more elevated; stains	72 hr.	0	0
	96 hr.: 3 mm.; stains; sharp outline	96 hr.	0	0
	168 hr.: 2 mm.; dense scar			
	Left cornea			
	24 hr.: 2.5 mm.; elevated advancing	Not aspirated		
	72 hr.: 3.5 mm.; ragged edges; stains			
	96 hr.: 4 mm.; stains in entire surface			
	168 hr.: 4.5 mm.; edges becoming sharper; less staining			
	240 hr.: 3 mm.; dense scar			
T_3	**Right cornea**			
	24 hr.: 1.5 mm.; elevated			
	48 hr.: 2.5 mm.; more elevated	48 hr.	1:6+	1:1,000+
	72 hr.: 2.5 mm.; stains	72 hr.	1:16+	1:1,000+
	96 hr.: 2 mm.; stains	96 hr.	1:16+	1:1,000+
	168 hr.: 2 mm.; faint scar	168 hr.	1:28+	1:1,000+
	Left cornea			
	24 hr.: 1 mm.; elevated	Not aspirated		
	48 hr.: 2 mm.; elevated			
	72 hr.: 2 mm.; elevated			
	96 hr.: 3 mm.; stains; edges slightly ragged			
	168 hr.: 2.5 mm.; quieting; edges sharp			
	240 hr.: 2.5 mm.; dense scar			
C_3	**Right cornea**			
	24 hr.: 2 mm.			
	48 hr.: 2.5 mm.; elevated	48 hr.	0	0
	72 hr.: 3 mm.; more elevated	72 hr.	0	0
	96 hr.: 3 mm.; ragged edges; stains	96 hr.	0	0
	168 hr.: 3 mm.; dense scar			
	Left cornea			
	Advanced as in controls on whom aspiration was not carried out, leaving dense scar—4 mm. in 240 hr.			

* C, controls; T, given injection of typhoid vaccine.
† The size refers to the diameter.

of the suspension of Staphylococcus was injected into both corneas. Twenty-four hours later well established typical ulcers were present in all the left eyes. Four of the right corneas were entirely devoid of any lesion; the fifth showed a tiny superficial ulcer at the site of the injection. Forty-eight hours later this small lesion had disappeared entirely, leaving no scar. The five other ulcers progressed as they would in unimmunized rabbits. Forty-eight hours after the corneal injections, when it was seen that little or no ulceration was to take place in the immunized eyes, the aqueous and blood were titrated. The titer of the aqueous from the right eye averaged 1:800+, that of the aqueous from the left eye, 0, and that of the blood, 1:460+. This effect was so striking that the animals were watched three weeks thereafter to note any possibility of a late infection. None occurred in the immunized eyes. At no time was there any noticeable shock or rise in temperature in any of the animals. It seems reasonable to conclude that the presence of the intra-ocular antibodies provided local "interference" with corneal infection produced by the injection of staphylococci.

ADMINISTRATION OF TYPHOID VACCINE FOLLOWING THE PRODUCTION OF CORNEAL ULCERS

In the preceding experiments the typhoid antibodies of the blood were induced and the titer of the aqueous was raised *before* the corneal ulcers formed. The following experiments were made to simulate more closely clinical conditions, i. e., therapy after the appearance of the lesion.

Corneal ulcers were produced bilaterally in a new series of rabbits by staphylococci. Ninety per cent of the animals presented beginning ulcers bilaterally twelve hours after inoculation. Those animals which did not have lesions bilaterally were not used. One half of the animals with beginning ulcers were given typhoid vaccine intravenously at this time and again daily until the experiments were finished. The other half were reserved as controls. Twelve hours after the first injection aqueous from the right anterior chambers of three immunized animals was aspirated. Aqueous from the right anterior chambers of the three control animals was likewise aspirated. The titer of the blood and aqueous at this time was 0. Twelve hours later aqueous from the anterior chambers of three other immunized animals was aspirated, as was aqueous from the anterior chambers of three controls. At this time aspiration was again carried out on the animals whose aqueous was aspirated at the end of the first twelve hour period. From this time onward aspiration was carried out on three different immunized and three control rabbits at each twenty-four hour period until the seventh day. At the same time the anterior chambers of all the animals in the preceding experiments were tapped at the end of the same twenty-four hour period, so that the anterior chambers, the aqueous of which was aspirated at the end of the first twelve hour period, had been tapped eight times on the seventh day. Aspiration before a positive titer of the blood was obtained reduced the progress of the ulcer very slightly. The average positive titer of the blood appeared on the third day and was 1:16. The concentration of aspirated aqueous following such a titer of the blood was an average of 1:8. From twelve to twenty-four hours after a positive titer of the aqueous was obtained the progress of the ulcers of the right eyes of the immunized animals was definitely curbed. As would be expected, the ulcers subjected to an earlier rise in the titer of the aqueous were most influenced. After the ulcers had been allowed to progress for five days or more they were not greatly affected by intra-ocular antibodies. The resulting scars were not very

different from those in the left eyes, the aqueous of which had not been aspirated. As in the preceding experiments, the unimmunized animals presented progressive ulcers with final dense scars.

EFFECT OF CONCENTRATION OF INTRA-OCULAR ANTIBODIES ON HUMAN CORNEAL ULCERS

It was at once obvious that if therapy of ocular inflammations by raising the concentration of typhoid antibodies in the aqueous was to be of service an effective titer would have to be obtained in a reasonably short time. A method of slow immunization for weeks as employed in the laboratory would be of little avail in the case of a severe, painful inflammation or in that of a rapidly spread corneal ulcer. Since it seemed that the intra-ocular antibody content was of greater importance than the shock and the rise in the temperature, a method [3] of rapid production of typhoid antibodies in the blood by repeated intravenous injections of small doses of vaccine was used. It was previously observed that an antibody titer of the aqueous of 1:6 was amply sufficient to "interfere" with the production of uveal activation and could be produced with a titer of the blood of 1:100+.[6] Such a titer of the blood can be produced in man by two intravenous administrations of a suspension of 5,000,000 typhoid bacilli, twenty-four hours apart. Such doses are unattended by great shock or a rise in temperature in the average human being. Twenty-four hours after the second injection aqueous may be aspirated, with a resulting titer of 1:8+. This procedure may be safely repeated at twelve hour intervals, so that a titer of the aqueous of 1:16+ is obtained twenty-four to thirty-six hours after the first aspiration. Thus an effective concentration in the aqueous may be obtained within fifty hours.

Since no untoward result occurred after many aspirations of rabbits' aqueous in the presence of corneal infection, the procedure was utilized at first in three cases of severe progressive corneal ulcer which seemed destined to perforate under ordinary treatment.

CASE 1.—A man aged 48 years was struck in the right cornea by a splinter while chopping wood. A dense ulcer formed twenty-four hours later and spread rapidly. Culture of material from this lesion yielded a mixed growth of Staphylococcus aureus, a slightly hemolytic strain of Streptococcus and the usual conjunctival organisms. The patient was treated with local antiseptics, atropine and the local application of heat, and later he was given injections of milk. Six days after the onset the ulcer was 4 mm. in diameter and very dense, with ragged edges, and involved the entire central portion of the cornea. There were marked conjunctival and ciliary injection and chemosis accompanied by great ocular pain. The patient was given typhoid H antigen containing 10,000,000 organisms intravenously. His temperature rose eight hours later to 101 F. and then subsided. Twenty-four hours later he was given a similar dose intravenously, and thirty-six hours later aqueous was aspirated with a fine needle. The antibody content of the aqueous was found to be 0. The culture was sterile. Twenty-four hours later there was

practically no chemosis or pain, and the edges of the ulcer looked cleaner and more sharply defined, with no extension. Twenty-four hours later aqueous was again aspirated; the antibody titer was found to be 1 : 16. From then on there was a reasonably rapid resolution of the lesion, so that four days later the surface was glossy and only a small area took the stain. There was never any exacerbation; the ulcer resolved completely, leaving a dense central scar 3 mm. in diameter.

CASE 2.—A man aged 60 years had herpes zoster of the ophthalmic branch of the fifth nerve. On the third day a large herpetic lesion appeared on the right cornea. This rapidly broke down and became secondarily infected. The cornea was insensitive. Twenty-four hours later there was a ragged superficial ulcer about 2 mm. in diameter, which stained in its entire surface. Smears and culture of the lesion showed a mixture of staphylococci and streptococci, which were undoubtedly secondary invaders. The epithelium became rapidly eroded, and the corneal resistance seemed very low, owing to the nature of the herpetic invasion. In spite of all local treatment the lesion spread with great rapidity. When seen, the ulcer was 4 mm. in diameter, very ragged and filled with débris.

An intravenous injection of typhoid antigen containing 10,000,000 organisms was given. Six hours later the patient had a severe chill, followed by a rise in temperature to 101.5 F. The height of the reaction passed in about two hours, leaving the patient comfortable. Twenty-four hours after the intravenous injection aqueous from the right eye was withdrawn through a fine needle into a syringe and was titrated and cultured. The titration gave negative results with all dilutions, and the culture was sterile. Owing to the fairly severe reaction following the first injection and the patient's debilitated condition, the second injection of 10,000,000 organisms was not given until forty-eight hours after the first. This was also done to promote the positive phase of antibody formation. At this time the ulcer appeared about the same as when first seen but had not progressed. Eight hours later the patient had another severe chill, and his temperature arose to 102.5 F. He complained of generalized aches, but within five hours his temperature had begun to drop, and he was fairly comfortable thereafter. Twenty-four hours after the second injection aqueous was again aspirated from the anterior chamber, and the titer was found to be 1 : 16. Eight hours following the aspiration the ulcer was distinctly improved in that the edges were more circumscribed, and there were less conjunctival chemosis and injection. Local treatment was continued to afford every possible aid. Twenty-four hours later the ulcer had shrunken 1 mm. by virtue of the fact that the infiltrated edges were clearer. The surface of the ulcer was cleaned with a small spatula and the débris cultured. This culture revealed the same organisms as former cultures. Aqueous was again aspirated; the titer of the aqueous was found to be 1 : 24. From this point the ulcer gradually became shallower, and the eye became quieter, and in ten days after the last aspiration the surface was completely clean, did not take a stain and had left a dense white scar 3 mm. in diameter.

CASE 3.—A man aged 43 years felt a sudden, sharp pain in his left eye while chipping stone. His companion looked at the eye and said that he removed a small foreign body. The pain subsided shortly, but that night the eye was "scratchy." The next day the eye was fairly red but not painful. The patient bathed the eye and used some home remedies. The eye continued to be red, and on the fourth day the patient had severe general ocular pain. When seen he had a deep central corneal ulcer 3 mm. in diameter. A smear of the ulcer's surface revealed a few diplococci. Culture established an almost pure strain of Pneumo-

coccus. The affected area stained almost in its entirety. An intravenous injection of typhoid antigen containing 10,000,000 organisms was given. This was followed by a slight general reaction but no rise in temperature. In thirty-six hours the patient was given a similar injection, which was followed by a slightly intensified reaction. Twelve hours after the second injection aqueous was aspirated. Titration revealed no antibodies, and the culture was sterile. Within eight hours the edges

TABLE 2.—*Synopsis of Cases in Which Corneal Ulcers Were Treated by Increasing the Intra-ocular Typhoid Antibody Content*

Case	Patient	Lesion*	Typhoid Vaccine Injected Intravenously	Time of Aspiration of Aqueous After Second Injection of Vaccine	Result and Final Vision
1	M. H., aged 48	Traumatic; mixed streptococcic and staphylococcic infection; rapidly progressive	10,000,000 organisms; 2 injections 24 hr. apart	36 hr. after 60 hr. after	Subsidence after first aspiration; final fairly dense scar; V = perception of movements of hand
2	A. M., aged 60	Ophthalmic herpes zoster; mixed infection	10,000,000 organisms; 2 injections 48 hr. apart	24 hr. after 24 hr. after	Eye quieted slowly in 10 days; scar left; V = perception of movements of hand
3	N. S., aged 43	Traumatic; pneumococcic infection	10,000,000 organisms; 2 injections 24 hr. apart	12 hr. after	Eye quiet in 10 days; small scar in 3 mo.; V = 20/30
4	C. M., aged 37	Dendritic ulcer; fourth attack	10,000,000 organisms; 3 injections 24 hr. apart	24 hr. after 60 hr. after	Rapid subsidence, then irritation; cleared after second aspiration in 36 hr.; faint scar in 4 wk.; V = 20/30
5	E. L., aged 41	Baby scratched cornea; 2 mm.; elevated; painful eye not yielding to local treatment in 5 days	10,000,000 organisms; 2 injections 24 hr. apart	12 hr. after	Rapid subsidence in 4 days; no scar; V = 20/20
6	M. K., aged 35	Dendritic; third attack; very resistant for 10 days	10,000,000 organisms; 2 injections 24 hr. apart	24 hr. after 72 hr. after	Indifferent subsidence after first aspiration; slow clearing after second aspiration; V = 20/40
7	M. L., aged 55	Traumatic; branch scratched cornea; no response to local treatment; ragged edges; advancing; mixed infection	10,000,000 organisms; 3 injections 24 hr. apart	24 hr. after 60 hr. after	Marked clearing of edges and rapid resolution after second aspiration; dense scar; V = 20/60

* The size refers to the diameter.

of the ulcer were more sharply defined and cleaner, and there was no advance. The eye was irrigated four times daily with physiologic solution of sodium chloride and was kept free from secretion; there was no other local treatment. Forty-eight hours after aspiration the eye was fairly quiet, and the ulcer was obviously clearing. In the presence of such a virulent organism it was deemed inadvisable to aspirate again, especially since the lesion was responding. Six days after aspiration the ulcer was 2 mm. in width and slightly elevated and could not be stained. The eye was kept constantly occluded, irrigated twice daily and kept free from secretion. In ten days there was a paracentral superficial scar 1 mm. wide. Three

months later there was a faint superficial scar just below the pupillary margin. The vision of this eye was 20/30 with correction. No other ocular lesions were noted.

After these satisfactory results were obtained, four smaller, less severe corneal ulcers were treated as recorded in table 2.

COMMENT

A previous communication dealt with the interference reaction of protein injected parenterally on heterologous protein injected intra-ocularly. It was found that injections of typhoid vaccine definitely interfered with reaction by organisms known to sensitize the eye when injected into the anterior chamber. The interference became much more marked when the intra-ocular antibody content was increased. Other heterologous proteins, such as egg white and horse serum, seemed likewise to interfere with each other when a larger quantity of one was injected into the anterior chamber before or simultaneously with the other. The inference was drawn that the intra-ocular antibody produced by the interfering proteins took up the available receptor cells, leaving few or none free for sensitization by the smaller quantity of protein given in the second injection. This hypothesis seemed consistent with the observations, so an analogy was drawn between these reactions and that of nonspecific protein in ocular inflammation.

Because typhoid vaccine is a popular protein for ocular therapy and produces an easily measurable antibody content, it was chosen for its action on experimental corneal ulcers. The marked resolution of fairly large ulcers following an increased antibody content of the aqueous, as compared to the definite advancement of ulcers in the unaspirated eyes, seemed too marked to be a coincidence. The element of time, as well as the concentration of antibodies, was found to be important. As might be expected, the earlier the antibody content was increased the sooner the lesion cleared, probably because of the smaller size of the lesion and the earlier action of interference and because the organisms had less time to acclimate themselves to the tissue. Antibodies resident in the unvaccinated animals seemed to exert an influence because of the definite retardation and earlier clearing of the lesions, as compared to those in the controls on whom aspiration was not carried out.

While the foregoing observations are illustrative of controlled laboratory experiments, they are not comparable in one important respect to the results in the clinical use of nonspecific therapy, as the vaccine was administered *before* the lesion was produced. The next set of experiments was thereupon done to conform more nearly with this important clinical condition. Naturally, the element of time was important under this condition, for the lesion was produced first and allowed to advance

for at least twenty-four hours before the first injection of typhoid vaccine was given. Aqueous of two rabbits with the most rapidly advancing ulcers was aspirated first, but this could not be done before fifty-four hours had elapsed after the initial inoculation of Staphylococcus. Nor was the antibody titer in the blood as high as it was in the previous animals. The marked retardation of the ulcers after aspiration of aqueous of the animals that received vaccine was unmistakable. The control animals whose aqueous was aspirated did not present the same rapid resolution without scar formation but did show definite retardation of a lesion after aspiration. These lesions in their much slower resolution destroyed more corneal tissue and left fairly large and dense scars. In no case was an eye injured by aspiration.

The action of increased concentration of intra-ocular antibodies in the seven cases of corneal ulcer in human beings was marked. The beneficial effect was apparently due to a greater concentration of typhoid antibodies in the aqueous. There were no noticeable untoward effects from aspiration, even in the extremely irritable eyes that were treated.

Paracentesis of the anterior chamber is more effective in raising the intra-ocular antibody content quickly and is probably safer in the presence of superficial corneal infections. It is conceivable that external irritants [1] might create enough superficial irritation to cause external spreading of the infection or irritate the corneal tissues sufficiently to cause them to become weakened. Puncture of the anterior chamber, if done cleanly and carefully, causes no intra-ocular contamination, because aqueous flows out and helps to cleanse the small puncture wound. In all the rabbit and human corneas so treated the wound closed at once without any particular local disturbance, even in the presence of the large areas of corneal infection.

ABSTRACT OF DISCUSSION

DR. CHARLES A. BAHN, New Orleans: Dr. Brown's painstaking experiments show that from a practical standpoint in some patients, at least, with ulcerative keratitis and some forms of uveitis the combination of injections of foreign protein followed by evacuation of the aqueous humor apparently hastens healing to a greater extent than either treatment alone.

I have used the treatment as recommended by him for one patient with an ulcer produced by pneumococci. There was rapid improvement after the evacuation of the aqueous. This case is so recent, however, that no definite conclusions can be drawn.

It has been approximately sixty-five years since Saemisch proved that the evacuation of the aqueous materially changed the course of hypopyon keratitis. Whether this is done by paracentesis, a trephine, a hypodermic needle or delimiting keratotomy is of minor importance.

Evacuation of the aqueous causes hypotony, with the rapid reformation of a new but chemically different aqueous.

In the past I have favored in this group of cases delimiting keratotomy, as described recently by Gradle and Gifford, because it evacuates the aqueous and also because it seems to place a barrier over the margin of the advancing ulcer. Unfortunately, at present the chemistry of, and even the fundamental types of, antibodies are not well known. It is known, however, that there are apparently a chemical and a physiologic difference between different kinds of antibodies.

In the case of typhoid antibodies, their recovery from the aqueous is more easily studied than that of some of the other antibodies.

Dr. Brown's experiments prove chemically what has long been known clinically, that the antibody content of the aqueous is diminished and that its quality is changed in the course of ulcerative keratitis and uveitis. Evacuation of the aqueous is both simple and safe. However, the efficiency of this treatment depends largely on its early use. When the inside of the eye has been badly poisoned, restoration of sight becomes more and more difficult.

Dr. Brown's method of producing standardized ulcers in the eyes of animals apparently marks a step forward, because great variations have been one of the principal obstacles in the experimental study of corneal ulcers in animals. I suggest that Dr. Brown's experiment be carried one step further. Retrobulbar injections of a slightly irritating or of a nonirritating foreign protein, combined with evacuation of the aqueous apparently would increase the antibody content of the eye, shorten the time which the combined treatment that he uses now requires and minimize the disagreeable general reaction that follows the intravenous injection of typhoid antibodies.

Mercuric cyanide has been used subconjunctivally and retrobulbarly as a chemical antidote in somewhat similar conditions. Why could one not use bacterial antidotes in that way?

Dr. Phillips Thygeson, Iowa City: In view of the confusion still existing in regard to the mechanism of foreign protein therapy, studies such as the essayist's are indeed welcome.

Dr. Brown in his opening remarks states that fever and leukocytosis have little, if anything, to do with the favorable results obtained with foreign protein therapy.

Before discussing the rôle and the beneficial effect of fever in foreign protein therapy it might be well to consider the action of fever alone, or perhaps I should say fever and leukocytosis as obtained by such an apparatus as the inductotherm. From the experience of my associates and me in the past year in Iowa City, it would seem that fever therapy is decidedly superior to foreign protein therapy, particularly in the treatment of iritis and gonorrheal ophthalmia, a finding which would indicate that the rise in temperature itself is important as a therapeutic agent.

It would seem from the reported series of experiments on rabbits that resistance to experimental staphylococcic infection paralleled the agglutinin titer for the typhoid bacillus of the blood and the aqueous. That this resistance was due to the intra-ocular concentration of typhoid antibodies is an assumption which, in my opinion, the experiments reported were not sufficiently complete to prove. Before typhoid antibodies can be established as the cause of the therapeutic effect it would seem to be necessary to eliminate all other agents. While Dr. Brown

has controlled the effect of fever, he has not eliminated other nonspecific effects such as (1) the mobilization of existing antistaphylococcic antibodies, (2) leukocytosis, (3) the increased bactericidal power of the blood and (4) the mobilization of histiocytes in the tissue. An experiment of some importance would have been a comparison of the therapeutic effect on experimental ulcers produced by staphylococci of normal serum and typhoid immune serum given intravenously and followed by aspiration of the aqueous. If typhoid immune serum were effective the case for typhoid antibodies would have been strengthened.

The fact that the typhoid bacillus contains the Forssman or heterophile antigen should also be considered.

Dr. Brown is to be congratulated on the basic type of investigation that he has been making. His clinical results from foreign protein therapy combined with aspiration of material from the anterior chamber certainly warrant clinical trial of his method in severe corneal infections.

DR. ALBERT L. BROWN, Cincinnati: As Dr. Bahn mentioned, delimiting keratotomy may owe some of its virtue to aspiration of aqueous from the anterior chamber, which in turn may increase the number of antibodies in the new aqueous. It is also conceivable that a scar produced may form a barrier to advancing infection.

The types of antibodies are naturally of great importance, but it is impossible to mention in a limited paper all that we have used. Briefly, we found that antibodies produced by milk, egg white, foreign erythrocytes, horse serum and diphtheria antitoxin were transient and unstable and that they could not be recovered from the aqueous in most instances and were removed only in minute quantities in a few cases even after paracentesis of the anterior chamber. On the other hand, typhoid antibodies were found to be stable, and they could always be recovered from the aqueous after paracentesis in the presence of a titer of the blood of 1:36+. Typhoid antibodies can often be recovered from the blood as late as two hundred days after one intravenous injection of the vaccine and can be reactivated by the injection of a dose smaller than the original one.

A retrobulbar injection of protein, I believe, would have much the same effect as a parenteral injection. We found that it was difficult to produce a considerable concentration of typhoid antibodies within the eye by subconjunctival injections of vaccine. This may be because the local circulation is rich and absorption is too rapid.

Subconjunctival injections of mercuric cyanide may possibly benefit because they produce local irritation, a feature that we have found capable of increasing the local concentration of antibodies. For example, we found that in the presence of a high titer of typhoid antibodies in the blood, local irritation of the eye would increase the concentration of antibodies in the aqueous. However, this could not be compared to the effect of tapping the anterior chamber.

I feel that the shock, fever and leukocytosis produced by the injection of protein are evidences of the formation of new antibodies in the blood and are not per se the beneficial factors. The fever in this form of therapy may be valuable in special types of ocular inflammation, for example, gonococcic, the optimum temperature for the gonococcus being below that which is often attained after an injection of milk. This is

not true for the majority of organisms and certainly not for the strain of Staphylococcus used in our experiments.

We have not used immune typhoid serum from another animal, for we felt that the use of a foreign blood serum would add another protein which would have to be considered. I believe that the experiments showing the difference in progress of the corneal ulcers under the influence of different intra-ocular concentrations of typhoid antibodies in the same animal are more clearcut, so far as the action of intra-ocular typhoid antibodies are concerned, than would be experiments in which the antibodies would be injected under the influence of or with a foreign blood serum.

RETROBULBAR INJECTION OF ANESTHETIC WITHIN THE MUSCULAR CONE

(CONE INJECTION)

WALTER S. ATKINSON, M.D.
WATERTOWN, N. Y.

The cone injection discussed in this article is a retrobulbar injection made just posterior to the globe within the muscular cone. The technic of retrobulbar or orbital injection differs greatly, as does the actual location where the solution is injected. It seems desirable to be more specific in referring to orbital injections because very different results may be expected when the injection is within and when it is outside the muscular cone.

About two months after cocaine was introduced by Koller,[1] Knapp[2] reported on the use of retrobulbar injection of cocaine hydrochloride to produce anesthesia for enucleation. However, this method of producing anesthesia of the globe did not meet with general approval, probably owing to the alarming toxic effects that followed the strong solutions of cocaine hydrochloride that were used. Some years later, Siegrist,[3] Löwenstein,[4] Seidel[5] and others revived the use of retrobulbar injection, using a weaker solution of cocaine hydrochloride, and less toxic drugs, such as procaine hydrochloride. Also, the addition of epinephrine hydrochloride to the anesthetic solution helped greatly to prevent its rapid absorption. In this way the toxic effect of the drug was diminished and the anesthesia prolonged.

Now orbital injection is used generally, and many operators employ this method as a routine for operations such as enucleation, extraction of a cataract, iridectomy and similar procedures.

The purpose of this communication is not primarily to uphold the merits of orbital injections, which have already been rather well established, but to emphasize the importance of how and where the solution is injected.

Read before the Section on Ophthalmology at the Eighty-Seventh Annual Session of the American Medical Association, Kansas City, Mo., May 14, 1936.

1. Koller, C.: Ber. ü. d. Versamml. d. deutsch. ophth. Gesellsch. **16**:60, 1884.
2. Knapp, H.: Arch. Ophth. **13**:402, 1884.
3. Siegrist, A.: Klin. Monatsbl. f. Augenh. **45**:106, 1907.
4. Löwenstein, A.: Klin. Monatsbl. f. Augenh. **46**:592, 1908.
5. Seidel, E.: Klin. Monatsbl. f. Augenh. **49**:329, 1911.

TECHNIC

The cone injection should be preceded by the usual instillation anesthesia. Temporary paralysis of the orbicularis muscle should also be produced if the operation is to be one in which a forcible contraction of this muscle would damage the eye, such as extraction of a cataract.

The Luer-Lok 5 cc. syringe (fig. 1) is very satisfactory for making the injection. It has a lock that prevents the needle from coming off

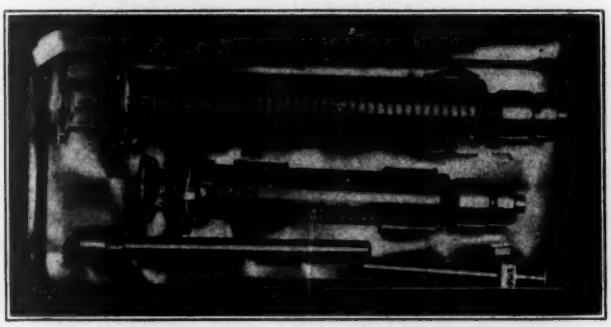

Fig. 1—Luer-Lok 2 cc. and 5 cc. syringes with needles.

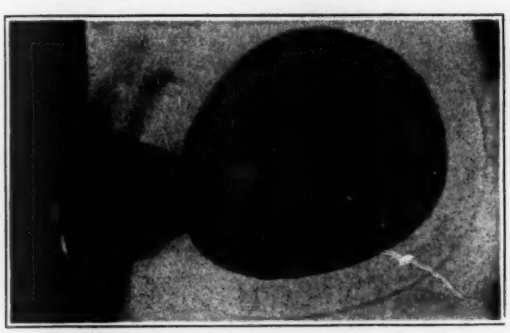

Fig. 2.—Intradermal wheal.

during an injection, is not damaged if placed in a boiling sterilizer and is lighter than the Labat syringe, which was formerly used and appears in some of the illustrations.

The platinum-iridium needles have been found more satisfactory than the steel needles. They seem to pierce the skin and tissues more easily; they do not rust, and they rarely become plugged. Two sizes of needle are used, a 25 gage needle 2 cm. in length and a 22 gage needle 3.5 cm. in length. These needles are supplied with protective metal shields which prevent the points from becoming dulled or turned.

With the small 25 gage needle an intradermal wheal is first raised a short distance below the inferior temporal margin of the orbit (fig. 2).

A 2 per cent solution of procaine hydrochloride, with a drop of epinephrine hydrochloride in a concentration of 1 : 1,000 to 10 cc. of diluent, is used.

When injection is made into the right orbit the patient is directed to look upward and to the left (figs. 3, 4 and 5). The 3.5 cm. needle is then introduced through the wheal, and the skin is moved upward with

Fig. 3.—Skull, showing position of the needle for retrobulbar injection within the muscular cone.

Fig. 4.—Retrobulbar injection within the muscular cone.

the needle so that the point just clears the inferior orbital margin. The needle is then directed upward and inward, midway between the external and the inferior rectus muscles, and advanced toward the apex of the orbit for a distance of from 2.5 to 3.5 cm., depending on the size of the orbit; as the needle advances a small quantity of solution of procaine is injected continuously. When the needle has reached a depth of from 2.5 to 3.5 cm. one should aspirate before injecting the solution, to make

sure that the needle has not entered a vessel. However, in this location it is practically impossible to enter a vessel unless there is an anomaly, since the vessels here are normally smaller than the needle and are freely movable. From 1 to 2 cc. of the solution of procaine hydrochloride is injected slowly, care being taken not to produce undue proptosis by giving too large an injection. For the majority of operations on the globe 1.5 cc. is usually sufficient, but for some operations on muscles and for enucleations 3 cc. or more may be injected, as a slight degree of proptosis does no harm and, particularly in painful eyes, a little more procaine may be desirable.

If a small amount of the solution of procaine hydrochloride is injected as the needle is introduced, practically no pain will be experienced. When resistance of the septum orbitale is encountered, it is well to pause to allow the procaine to take effect.

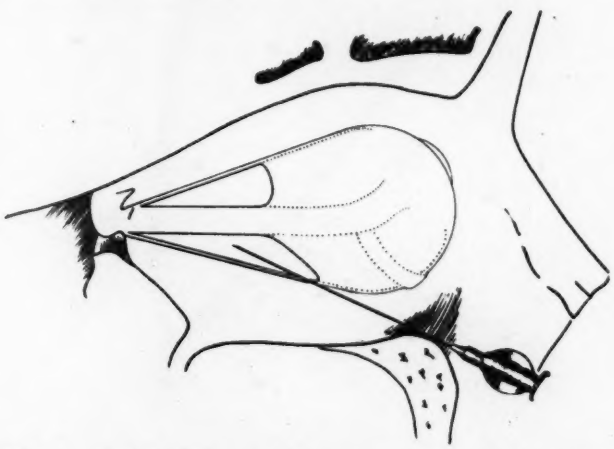

Fig. 5.—Diagrammatic sketch showing the eye turned up and away from the site of the injection, thus moving the fascial extension forward and up out of the way.

When the needle is withdrawn pressure should be made at once over the site of the injection, the skin being pressed against the malar bone at the orbital margin, thus preventing bleeding at this point. Pressure is also exerted on the globe through the lids with a slight rotary motion, so that the solution of procaine hydrochloride is more thoroughly diffused within the muscular cone. The operation may then be begun.

COMMENT

For enucleations and operations in which there is considerable traction on the muscles and in which a reduction of tension is of little consequence, it is advisable to wait five or ten minutes before beginning the operation.

By means of the injection within the muscular cone all the sensory nerves to the eyeball are blocked, and complete anesthesia of the globe is obtained, regardless of how greatly inflamed or painful the eye may be. Pressure on the inflamed eye, which before the injection caused severe pain, is not noticed now. The rectus muscles, except the superior rectus muscle, are also rendered practically insensitive to traction.

The injection within the muscular cone also causes paresis of the rectus muscles, except the superior rectus, so that the patient cannot easily look down. Therefore, for such operations as extraction of cataract it is advisable to use a suture under the superior rectus muscle (bridle suture), but with the rectus muscles inactive little traction is required to hold the eye in the desired position. Also, better fixation of the globe is thus obtained.

The superior rectus muscle usually remains active and may be sensitive to traction. To prevent pain when the superior rectus muscle is picked up for the introduction of a bridle suture or for an operation in which there is traction on this muscle, additional anesthesia is necessary. This may be accomplished by making an injection of 0.5 cc. of solution of procaine hydrochloride and epinephrine hydrochloride through the conjunctiva of the upper culdesac.

With the superior rectus muscle active and with paresis of the other extrinsic muscles, there is torsion of the globe, with rotation toward the nose. The torsion is increased when a suture is used under the superior rectus muscle. Therefore, if iridectomy is performed it should be done from 10 to 15 degrees nasally so that the coloboma will be at axis 90 when the muscles again function normally. While this is of no particular importance from a visual standpoint, a coloboma looks better in the vertical meridian.

When the eye is red and inflamed, as in acute glaucoma, a subconjunctival injection should also be given, since the inflamed conjunctiva is not well anesthetized by topical application. Only the conjunctiva immediately surrounding the cornea for a distance of about 3 or 4 mm. is rendered insensitive by an injection within the muscular cone, since its nerve supply is from the ciliary nerves which are within the cone. The rest of the conjunctiva is innervated by the supra-orbital, supratrochlear, infratrochlear, infra-orbital, and lacrimal nerves, all of which are outside of the muscular cone and are not reached by the injection within the cone. If the eye is inflamed less pain is caused if the subconjunctival injection is given after the retrobulbar injection. For the subconjunctival injection the needle may be introduced through the insensitive conjunctiva directly surrounding the cornea, and if succeeding injections are made through anesthetic blebs little pain will be experienced. In this way pain due to the use of fixation forceps and

to suturing the conjunctiva after enucleation is avoided in eyes that are inflamed and painful.

With such complete anesthesia of the globe and with the eye practically immobile, together with paralysis of the orbicularis muscle, an operation on the globe can be performed with the same deliberate precision that one can use when operating on a pig's eye.

Having the patient look upward and away from the site of the injection allows easier access to the muscular cone. The extension of the fascial sheath of the muscles which closes the spaces between the rectus muscles for a short distance back of the globe is in this way moved forward and upward out of the way so that the needle does not strike it, as is shown diagrammatically in figure 5. If the needle does strike the sheath, pain ensues. The sheath is also somewhat tough,

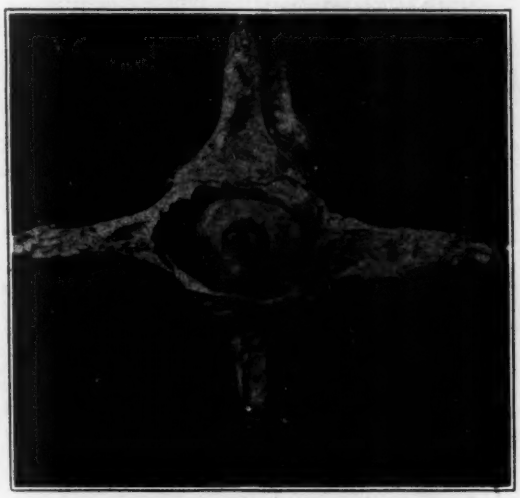

Fig. 6.—Posterior view of the eyeball, showing the fascial sheaths and, in part, the fascial extension which closes the spaces for a short distance back of the globe (from Whitnall[6]).

and the needle does not penetrate it easily, thus causing the globe to rotate, which to some extent interferes with the introduction of the needle and the equilibrium of the patient.

Procaine hydrochloride injected within the muscular cone is apparently held within the cone, since the nerves outside of the cone are rarely affected. How is the solution of procaine hydrochloride held within the muscular cone, since there is no demonstrable fascia between the rectus muscles, posterior to the globe, as they converge to their attachment at the apex of the orbit? Anteriorly, the escape of fluid is prevented by the globe, surrounded by Tenon's capsule, and by the adjacent margins of the sheaths of the four rectus muscles, which are

continuous with one another with a wide sweep between them, as shown in figure 6, from Whitnall.[6] In this manner an intramuscular membrane is formed which, according to Whitnall, exists for a short distance behind the globe. Beyond this the muscles converge to their attachment through the annulus of Zinn at the apex of the orbit, and their margins become closer together, leaving comparatively little space between them. In this location the escape of the solution of procaine hydrochloride is probably prevented, or at least retarded, by the closely packed layer of fat with its connective tissue reticulum.

According to Whitnall,[7] the orbital fat, which fills the entire space in the orbit not occupied by other structures, varies in consistency in different regions. Within the muscular cone the fat has the appearance of large and loosely connected lobules, broken up by the passage of the nerves and vessels. Outside of the muscular cone the fat is more firmly and closely packed and contains a quantity of connective tissue which

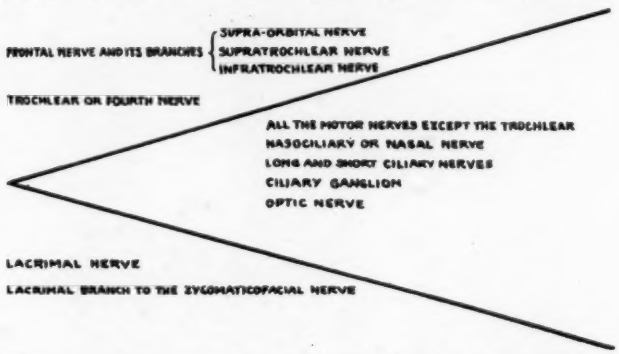

Fig. 7.—Diagram of nerves within and outside of the muscular cone.

is closely attached to the muscular sheaths. No doubt this fat and connective tissue serve as a sufficient barrier so that the anesthetic solution is held within the cone, thus causing anesthesia or blocking of the nerves that traverse it, namely, the nasociliary nerve, the long and short ciliary nerves, the ciliary ganglion, the optic nerve and all the motor nerves except the trochlear, or fourth, nerve (figs. 7 and 8).

In the operation for cataract extraction, a decrease in the intra-ocular tension seems to be an advantage, as it lessens the possibility of prolapse of vitreous. In extraction with capsulotomy it is often a little more difficult to express the lens when the tension is decreased. In deeply set eyes the operation is somewhat facilitated if the eye is slightly proptosed. The decrease in the intra-ocular tension following the injection of procaine hydrochloride and epinephrine hydrochloride into the

6. Whitnall, S. E.: The Anatomy of the Human Orbit and Accessory Organs of Vision, New York, Oxford University Press, 1921, p. 290, fig. 151.

7. Whitnall,[6] p. 297.

cone may be accounted for by the constricting action of the epinephrine on the arteries entering the globe but would not impede its exit through the venae vorticosae, since the solution does not reach them, located as they are in the episcleral space. The free anastomosis of the venae vorticosae and other orbital veins with the facial vein would allow free exit of the blood.

There is often a noticeable deepening of the anterior chamber, particularly when the amount of epinephrine hydrochloride is increased. This would indicate a decrease in the fluid contents of the eye posterior to the diaphragm. This makes the incision easier in operations in which there has been a shallow anterior chamber. Also, with the pressure behind the lens lowered, the anterior capsule appears to become more relaxed. Some lens capsules that were examined with the slit lamp

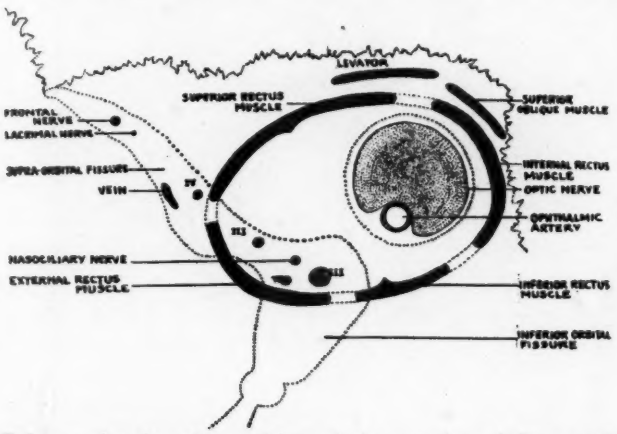

Fig. 8.—Scheme showing the position of the annulus of Zinn and the relative position of the nerves.

prior to operation and that appeared to be too tight to be grasped with smooth forceps, after a cone injection were found to be loose so that a good bite of capsule could be obtained with the forceps.

With a lowered tension the iris may not prolapse well in corneoscleral trephinings, an incident which may be embarrassing. However, in glaucomatous eyes the tension is usually lowered slightly (unless a much higher concentration of epinephrine is used).

Newly formed aqueous, which Duke-Elder [8] termed "plasmoid aqueous," contains a larger proportion of colloidal molecules or plasma proteins than does the normal aqueous. If this is a dialysate due to dilatation of the capillaries of the ciliary body following the escape of the normal aqueous, the injection of solution of procaine hydrochloride and epinephrine hydrochloride into the cone not only would be of value

8. Duke-Elder, W. S.: The Nature of the Intra-Ocular Fluids, London, George Pulman & Sons, Ltd., 1927.

as an anesthetic but, as was pointed out by Friedenwald,[9] would prevent a postoperative rise of tension. The action of the epinephrine reduces the edema of the intra-ocular tissue, particularly that of the ciliary body and processes. Thus the dialysis is limited, and more nearly normal aqueous is formed, which diminishes the occurrence of so-called plastic iritis and the formation of synechiae.

Löwenstein [4] advocated injection into the ciliary ganglion to produce anesthesia for the enucleation of inflamed and painful eyes. A 5 cm. needle was introduced through the conjunctiva temporally just below the margin of the external rectus muscle, for a distance of 4.5 cm.

Later Elschnig modified the technic and introduced the needle through the skin at the inferior temporal margin of the orbit rather than through the conjunctiva. The pain caused by traction and pressure on painful eyes is thus avoided. The method also allows easier access to the muscular cone. In observations on the cadaver Löwenstein noted that the optic nerve was often pierced with the 5 cm. needle and that dyes could be injected into the optic sheath readily without their being found free in the orbit. This indicates how easily the optic nerve may be injured if a 4.5 or 5 cm. needle is used. The procedure of Löwenstein has been referred to as injection into the ciliary ganglion. It is not surprising that many surgeons hesitated about trying it, and well they might, if it is taken literally. It would require the most exact technic to make an injection into the tiny elongated ganglion, 2 mm. in length, lying as it does in the orbital fat within the muscular cone, about 1 cm. in front of the annulus of Zinn, between the external rectus muscle and the optic nerve, close to the ophthalmic artery. That it is desirable to block the ciliary ganglion for many operative procedures is not questioned. But this can be done safely and easily by using a 3.5 cm. needle and injecting the anesthetic solution more anteriorly within the muscular cone. In this location, owing to the loosely connected globules of fat, the solution diffuses quickly and permeates thoroughly the ciliary ganglion.

Duverger,[10] after experiments on the cadaver with needles of various lengths, concluded that a 3.5 cm. needle is preferable for all orbital injections except those to be made at the extreme apex, and for these he found that the 4.5 cm. needle was just long enough to reach the optic foramen but not long enough to pass through it.

With the 3.5 cm. needle Duverger was unable to pierce the optic nerve even after removing the temporal portion of the orbital wall, so that he could observe the point of the needle which had been introduced at the inferior temporal margin of the orbit. When the point of the needle

9. Friedenwald, J. S.: Am. J. Ophth. **15**:191, 1932.

10. Duverger, C.: L'anesthésie locale en ophthalmologie, Paris, Masson & Cie, 1920.

approached the nerve it always eluded it, because in this location the nerve is freely movable. The same property applies to the vessels here. They are also very small, so that the risk of injuring them is slight. Nevertheless, orbital hemorrhage is often mentioned as an objection to retrobulbar injections. Data on over 8,000 retrobulbar injections showed eight orbital hemorrhages, five of which were admittedly due to faulty technic. In no instance was the eye damaged. If a 4.5 or 5 cm. needle is used and the point is carried to the apex of the orbit, obviously a vessel or the optic nerve may easily be pierced, because here vessels and nerves converge to reach their bony exits and are fixed. This danger is avoided by the use of a 3.5 cm. needle.

For painful blind eyes in cases in which it is desirable to retain the eye or in which permission for enucleation is refused, an injection of alcohol into the cone will often relieve the pain and allow the patient to keep the eye. The needle is introduced as for the usual cone injection, and from 1 to 1.5 cc. of a 2 per cent solution of procaine hydrochloride with epinephrine hydrochloride is injected. The syringe is removed from the needle, and pressure is exerted on the globe through the closed lids for a few minutes to allow the anesthetic solution to become thoroughly diffused within the cone. A second syringe containing absolute alcohol is then attached to the needle, and from 1 to 1.5 cc. is injected. A pressure dressing is then applied. If the patient is given 1½ grains (0.1 Gm.) of phenobarbital and a compound tablet of acetylsalicylic acid, acetophenetidin and caffeine one-half hour before the injection, little pain will be experienced. The operation is a comparatively minor procedure and may be done in the office, which is a consideration with many patients.

CONCLUSIONS

Undoubtedly many intra-ocular operations may be successfully performed with no apparent discomfort in a large proportion of patients with instillation anesthesia only or with instillation anesthesia combined with subconjunctival injection. There is, however, a small percentage of patients who either are not sufficiently anesthetized by this method or are less stoical than others. Since it is not possible before operation to select these patients, it seems wiser to err on the side of always obtaining complete anesthesia, which may be accomplished by the method described in the foregoing pages. By obtaining complete anesthesia, with paresis of the extra-ocular muscles combined with paralysis of the orbicularis muscle, many operative accidents may be avoided.

Clinical Notes

A "PARASOL" FOR USE IN OPHTHALMIC SURGERY

BRYED WILSON, M.D., CHICAGO

In many ophthalmic operations performed with the eye under local anesthesia it is desirable to keep the eye not under operation open in order to facilitate movement of the eye being operated on as needed to enhance the ease and security of the operative procedure. This is particularly true in operations on the extrinsic muscles, magnet operations, iridectomy or cataract extraction.

The ophthalmic surgical parasol.

In an operation for cataract a "parasol" device is particularly valuable when the eye not operated on has previously been operated on for cataract and is therefore aphakic and highly sensitive to light. In such instances the light used during operation glares into the eye not being operated on almost intolerably, so that the patient constantly attempts to close the eye or looks hither and yon in an attempt to avoid the discomfort of the glare, thereby markedly interfering with the ease and progress of the surgical procedure.

To avoid such trying and sometimes embarrassing experiences a "parasol" has been devised. This device consists of a keystone-shaped welder's lens of no. 5 or 6 density, such as is used in acetylene welding. It was found on trial that nothing less than this lens sufficiently excluded the glare so as to accomplish the purpose desired. This glass plate is framed in a metal rim to preclude danger of breakage, and the rim is mounted on a frontal and a maxillary stilt. These stilts were, from experience, found to be necessary in order that the eye not under operation should be able to see from underneath the rim of the parasol.

Sterilization by means of phenol and alcohol or other similar preparations is easily accomplished.

The device is easily secured on the patient's face by narrow adhesive strips and is sufficiently low so that it does not interfere with the surgeon's hands.

This device obviates the necessity of a focused spotlight held by an assistant, which in my experience has been unsatisfactory because of lapses in attention on the part of the assistant to that particular and important detail because of his interest in observing the operation. With the use of this parasol an adequate and well adjusted operating room light properly focused on the patient's face will cause him no discomfort, and such a light is superior for surgical purposes to any small area of intense illumination derived from a hand lamp held by an assistant.

The accompanying illustration shows the method of fastening the parasol over the patient's eye and illustrates how the stilts allow the eye to see from under the edges of the parasol. The illustration shows a lens of toric curve.[1] With the use of the stilts a flat lens is fully as adequate and considerably reduces the cost of manufacture.

1. Manufactured by Belgard, Inc., 6 North Michigan Avenue, Chicago.

Ophthalmologic Review

EDITED BY DR. FRANCIS HEED ADLER

EPICANTHUS AND ITS VARIANTS AMONG CAUCASIANS

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NEW YORK

Epicanthus is not a new or extremely rare condition, and one finds scattered through the literature reports of isolated cases.[1] It is my purpose in this paper not to offer a bibliographic review of epicanthus (the reader is referred to the work of Forster [2] and Brückner [3] for good clinical reviews) but rather to present a critical analysis of the condition in the light of recent developments in the field and of my own clinical observations.

DEFINITION

I present the following material merely as a means of introducing the discussion of the subject, as I shall try to show that epicanthus is a far more complex condition than the simple description given leads one to believe: In the "American Encyclopedia and Dictionary of Ophthalmology" [4] epicanthus is described as follows:

> a congenital deformity in which a fold of skin, with its concavity lateralwards extends from the side of the nose and partly covers the inner canthus. A similar fold of skin at the outer commissure has been described as external epicanthus. In the Mongolian races a slight degree of epicanthus is naturally present, giving to these people their characteristic expression about the eyes. In the Caucasian race it constitutes a deformity that may require operation for its correction. It is frequently associated with other deformed conditions, such as ptosis, ankyloblepharon, convergent strabismus, microphthalmos, etc.

1. (*a*) Posey, W. C.: Case of Epicanthus, Tr. Coll. Physicians Philadelphia **39**:374, 1917. (*b*) Rosenstein, A. M.: Epicanthus und Heredität, Med. Welt **5**:354,1931. (*c*) Ross, N.: Congenital Epicanthus and Ptosis, Transmitted Through Four Generations, Brit. M. J. **1**:378, 1932. (*d*) Saller, K.: Mongolenfalte bei einem Europäer, Med. Welt **7**:1510, 1933.

2. Forster, A.: Zur Morphogenese des Epicanthus und der Falterbildungen der Haut in der Nasenwurzelgegend, Anat. Anz. **52**:49, 1919-1920.

3. Brückner, A.: Kenntnis des congenitalen Epicanthus, Arch. f. Augenh. **55**:23, 1906.

4. Wilder, W. H.: Epicanthus, in Wood, C. A.: The American Encyclopedia and Dictionary of Ophthalmology, Chicago, Cleveland Press, 1915, vol. 6, p. 4477.

The condition may also be hereditary and has been reported as occurring in several generations of the same family. A mild degree of epicanthus is frequently seen in young children which may be regarded as temporary, for it disappears with the development of the bridge of the nose.

And further: [5]

a rather common anomaly due to excessive development of the skin over the root of the nose. The fold may be obliterated by pinching up the skin over the bridge of the nose. The folds represent simply duplications of skin which are in direct connection with the skin of the bridge of the nose.

REVIEW OF THE LITERATURE

The Significance of Epicanthus.—There appears to be confusion as to the exact significance of epicanthus, especially with respect to its anthropologic and ethnologic import. That it occurs normally in Mongolians is a fact generally accepted. There are those, however, who do not share this belief, among whom may be listed Motais,[6] who had occasion to study the eyes of the natives in Cochin-China. He described as normal a *bride* or fold, in contradistinction to an epicanthus, as follows (in translation):

The skin beneath the brow describes a gentle curve with its concavity anteriorly and falls then as a rigid curtain, without folds, just in proximity to the lashes. It then turns sharply in a backward direction and into the skin to form a deep palpebral groove, which disappears when the eyelids are opened. This Mongolian apron terminates imperceptibly above the external canthus; in its internal portion it continues without transition with the Mongolian fold, which covers, in part, the internal commissure, the caruncle, extending only to reach the internal extremity of the inferior lid.

This band differs greatly from the epicanthus, with which it is often compared.

Epicanthus concerns the skin of the region lateral to the nose. Its inferior insertion terminates in the cheek; its superior, in the middle of the internal portion of the superior lid. It has a concavity freely external.

The bride mongolique, on the contrary, involves only the skin of the superior lid and reaches the inferior lid only to disappear; it continues simply the pad of which it is a part. Its concavity is inferiorly external.

Gifford [7] expressed the same opinion as Motais and presented statistics to show that epicanthus is almost as frequent in Caucasians as in Mongolians.

Crookshank [8] described a vertical type of epicanthus "placed across the canthus in such a way that portions of both the upper and the lower

5. Hardy, W. F.: Epicanthus, in Wood, C. A.: The American Encyclopedia and Dictionary of Ophthalmology, Chicago, Cleveland Press, 1915, vol. 4, p. 2791.

6. Motais, F.: Trois années d'ophtalmologie en Cochinchine, Ann. d'ocul. **162**:661, 1925.

7. Gifford, H.: The "Mongolian Eye," Am. J. Ophth. **11**:887, 1928.

8. Crookshank, F. G.: The Mongol in Our Midst: A Study of Man and His Three Faces, New York, E. P. Dutton & Co., Inc., 1924.

eyelids are covered, the concavity of the semilunar fold itself looking outward," and an oblique fold "of loose skin just above the inner angle, impinging on the eyelashes and covering the canthus, without necessarily hiding any part of the lower lid." The oblique fold, he said, is characteristic of the Mongolian, the vertical fold being found in all races in fetal stages.

Wen,[9] in an attempt to answer challenges such as the one just cited, utilized histologic studies in his approach to the problem. Using thirty fetuses from 15 to 40 weeks old, which included 9 white and 21 Chinese fetuses, he made serial sections from the medial angle of the eye. His findings were as follows:

> The fold formation in the skin of the upper lid generally starts in the middle of the palpebral portion as a horizontal and slightly curved furrow which is recognizable in specimens of about 20 weeks. Subsequently, owing to the growth of the underlying structures, this furrow gradually becomes deeper and extends both medially and laterally. Its lateral portion in practically all cases ends on the surface, while the medial one in certain instances often curves in deeply to the inner angle of the eye and continues with the skin of the free edge of the upper lid as it turns downward to meet the lower lid . . . this part of the fold is closely associated with the formation of the epicanthic or so-called mongolic fold of the Chinese eye. . . .

He found this skin fold present in all the fetuses from 5½ months to term, and he was able to classify the folds of the entire series into two main types, particularly with respect to their situation on the upper lid, as follows:

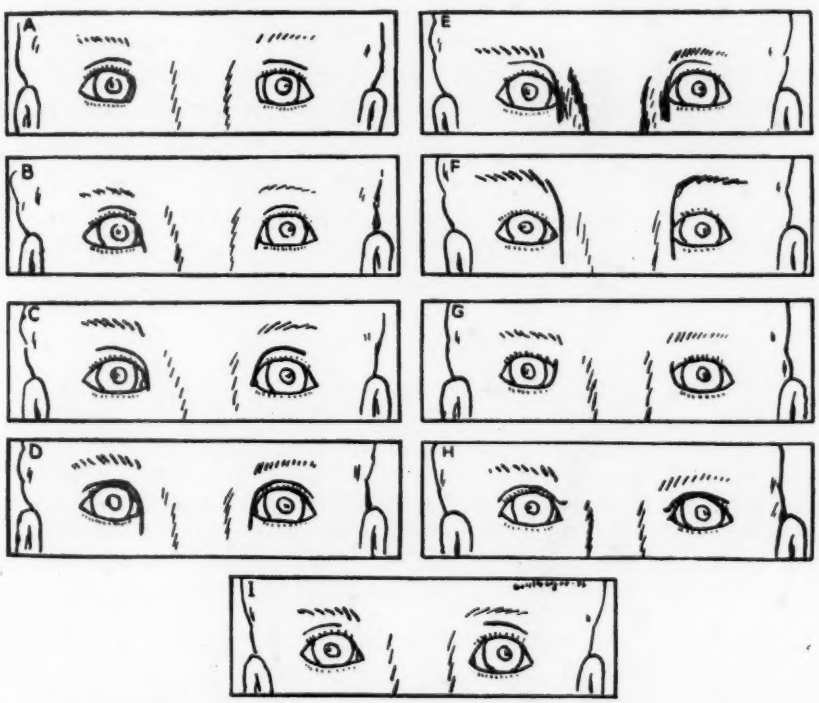
1. Caucasian type. The fold is rather highly placed at a level of about the boundary between the pars orbitalis and the pars tarsalis of the eyelid. Histologically, the medial portion ends on the surface of the lid and gradually diminishes in size as it is traced toward the bridge of the nose. In the epicanthic region there is no fold of any sort detectable.

2. Chinese type. The fold extends along the lower border of the upper lid, either over the tarsal plate or even as low as the evelashes. Histologically, the medial portion of the skin turns in deeply at the inner angle of the eye. The fold becomes thicker as it is followed toward the medial direction and extends obliquely and downward toward the lower lid. Corresponding to this thick fold the characteristic kink of the orbicular muscle plate becomes more pronounced here than elsewhere, and the amount of fat tissue deposited in the central connective tissue plate also is greatly increased. Meanwhile, some of the tendon fibers of the levator palpebrae muscle can be traced to the deep surface

9. Wen, I. C.: The Development of the Upper Eyelid of the Chinese with Special Reference to the Mongolic Fold, Chinese M. J. **48**:1216, 1934.

of the skin of the fold. In such cases it may be said that the medial portion of the skin fold participates in the formation of the typical epicanthus.

Wen thus concluded: "This epicanthic fold is therefore produced by the internal structures rather than, as thought by most authors, by the loose skin of the upper lid." It is thus suggested that the identification of the epicanthus as a feature of the Mongolian eye should rely on the internal structures mentioned rather than on the mere size and shape of the loose skin of the upper lid.



A, first degree epicanthus; *B*, second degree epicanthus; *C*, third degree epicanthus; *D*, epicanthus tarsalis (after von Ammon); *E*, epicanthus palpebralis; *F*, epicanthus supraciliaris; *G*, epicanthus inversus (after Luo); *H*, horizontal (false) epicanthus, and *I*, a normal eye.

Types of Epicanthus.—On an anatomic basis von Ammon [10] formulated the following types of epicanthus:

1. Epicanthus supraciliaris bilateralis. This begins from the eyebrows and extends downward toward the tear sac or farther toward the nostril, without reaching them however (fig. *F*).

10. von Ammon, F. A.: Der Epicanthus und das Epiblepharon: Zwei Bildungsfehler der menschlichen Gesichtshaut, J. f. Kinderkr. **34**:313, 1860. Lithographs are reproduced, and an excellent bibliography is presented.

2. Epicanthus palpebralis. This arises in the skin of the upper lid above the tarsal fold and extends to the lower orbital margin, where it ends in the cutis (fig. *E*).

3. Epicanthus tarsalis. This originates in the tarsal fold of the upper lid and loses itself in the skin close to the inner canthus (fig. *D*).

A fourth type, epicanthus inversus, has been described by Braun and by Luo [11] as a fold of skin starting from the lower lid and extending upward in the form of a small arc, ending at the mesial end of the unaffected upper lid. The inner canthus is not covered by the fold but is displaced a little outward, thus increasing its distance from the bridge of the nose. This causes the palpebral fissure to be shortened and to appear somewhat oblique, turning from below and inward in an upper and outward direction. Congenital ptosis was present in cases of this type (fig. *G*).

Mention should be made of the distinction between the horizontal (false) and the vertical type of epicanthus.

Another classification which has received recognition is that of Drews,[12] who recognized three degrees:

1. First degree—the Mongolian eye. This anomaly is typical of the normal Japanese eye. Drews said:

> The fold begins at the outer corner of the eye and runs somewhat above and parallel to the free edge of the lid toward the inner corner of the eye in such a manner that it overlaps the edge of the lid and partially covers the eyelashes so that these appear as if growing from inside the eye. On the inner corner of the eye the fold assumes a crescent-shaped course toward the lower lid and vanishes in the skin of the upper cheek so that the corner appears semicircular and the ending of the tear duct is covered wholly or in its greater portion.

This description of course tallies exactly with that of Motais and depicts the condition for which Gifford has suggested the term hemiepicanthus, and Crookshank has offered the name oblique type of epicanthus, although, as has been suggested, Wen stated that this is merely a variation of a fundamental type and is not distinct from the vertical forms (fig. *A*).

2. Second degree—a not fully developed Mongolian eye. Here, a fold beginning in the inner end of the upper lid runs crescent-shaped over the caruncle, which it wholly or partially covers. There is also a more or less distinct fold, somewhat above and parallel to the free edge

11. Luo, T. H.: Bilateral Congenital Epicanthus Inversus and Ptosis: Report of Case, Chinese M. J. **48**:814, 1934.

12. Drews, R.: Ueber das Mongolenauge als provisorische Bildung bei deutschen Kindern und über den Epicanthus, Arch. f. Anthropol. **18**:223, 1889.

of the lid; this, however, does not extend to the inner corner of the eye and does not overlap the edge of the lid which is visible (fig. *B*).

3. Third degree. Here the fold is only faintly indicated or poorly developed, being residual in nature (fig. *C*).

Etiology.—Sichel [13] (1853) found a peculiar configuration of the nasal bones in the cases of epicanthus that he studied, namely, a flattening and lateral spread of the bones which resulted in the loss of the arch of that region. Thus, the skin, which was insufficiently supported and stretched by the arch, here overlapped and formed the epicanthus.

Von Ammon [10] (1860) explained the condition as being due to the fact that the skin of the face develops at a much faster rate than the bones, lying loosely in the fetal and infantile stages. Therefore, when the bones develop with the aging of the child the epicanthus disappears.

Ranke [14] (1894) attempted to explain the epicanthus normally present in Mongolians on the basis of anatomic variations in the nasal bones.

Keith [15] (1913) described epicanthus as an embryologic form seen in fetuses of all races.

Martin (quoted by Usher [16]) stated that the location of the insertion of the tendon of the levator palpebrae superioris muscle is the determining factor and described its low insertion in Mongolians in contradistinction to the high insertion in the upper lid in Caucasians.

Chouke [17] (1929) in a statistical study stated as his conclusion that epicanthus is found in persons having extraordinarily small superciliary arches and a flattened root of the nose, although, conversely, this cannot account for the presence of the epicanthus completely. A temporarily retarded development of the bones of the forehead, at least relative to the growth of the small parts, also may play a part in the formation. Epicanthus is not related to brachycephaly or dolichocephaly.

The work of Wen [9] (1934) in which he placed the anatomic and histologic explanation of epicanthus on a firm basis (an idea which Martin in 1914 first conceived) has already been discussed.

Discussion of the etiology of epicanthus would not be complete without consideration of the point of view of many clinicians, namely, that

13. Sichel, J.: Ueber die angeborene Augenwinkelfalte oder den Epicanthus congenitus und hereditarius, J. f. Kinderkr. **18**:4, 1852.

14. Ranke, J.: Der Mensch, Leipzig, Bibliographisches Institut, 1894, vol. 2, p. 312.

15. Keith, A.: Human Embryology and Morphology, ed. 3, London, Edward Arnold & Co., 1913, p. 196.

16. Usher: A Pedigree of Epicanthus and Ptosis, Ann. Eugenics **1**:128, 1926.

17. Chouke, K. S.: Epicanthus or Mongolian Fold in Caucasian Children, Am. J. Phys. Anthropol. **13**:255, 1929.

it has a hereditary basis. In fact, Fortuyn [18] has gone so far as to state: "From race crossings between the Chinese and the White race, the appearance of an epicanthus is not controlled by the environment but by the presence or absence of a single gene."

The literature contains numerous reports of the occurrence of the condition in families even through four generations,[1c] and Usher [16] collected many such case histories and has presented an extensive bibliography on this phase of the subject of his article.

Notwithstanding this, there have been many cases reported and observed (as in my case) in which no hereditary basis could be found. This will be discussed further.

Incidence of Epicanthus.—As has been said, it was early observed that epicanthus was a not uncommon occurrence in persons of the white race who were otherwise normal and possessed of no other physical or mental stigmas.

Martin,[19] from a survey made in Munich, gave the figures shown in table 1. Drews,[12] using the classification that he proposed, gave the figures shown in table 2, which indicate that epicanthus, so common in children, has a definite tendency to disappear.

ORIGINAL WORK

My series covers twelve hundred persons, in twenty-four of whom epicanthus of one of the types described was present. This does not include the forty-two who were found to possess epicanthus of the third degree. In an attempt to attach significance to the type of anomaly found and the physical and racial characteristics of the persons observed, the data were collected as shown in table 3.

With the von Ammon classification as a criterion, it was found that no adult presented epicanthus supraciliaris. I saw two examples of this condition in Italian children, a girl of 6 and a boy of 5 years. There were four instances of epicanthus palpebralis: in one Italian male, one French female and two Jewish females.

Epicanthus tarsalis includes the usual types of epicanthus and its variants described in the literature, and it simplifies matters to consider Drew's types as subdivisions of this group as follows:

1. First degree epicanthus (hemiepicanthus; oblique epicanthus; *bride mongolique*). Four instances were observed: two Jews (male), one Italian (female) and one Scotchman.

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18. Fortuyn, A. B. D.: Modern Research in Human Twins, Quart. Rev. Biol. **7**:298, 1932.

19. Martin, R., quoted by Usher.[16]

2. Second degree epicanthus. Sixteen cases of this type were observed, distributed among those not mentioned under the previous headings.

3. Third degree epicanthus. Forty-two persons not included in the previously mentioned groups were found to possess this type of fold, a residual epicanthus. At the time these were observed I did not consider the anomaly to represent a type of epicanthus and merely recorded the incidence with no further notes.

TABLE 1.—*Data on Epicanthus Collected by Martin*

Age	Males, Percentage	Females, Percentage
1- 6 months	33.1	32.6
7-11 months	25.6	25.5
In second year	20.3	18.0
3- 6 years	14.0	5.1
7-11 years	4.4	3.2
12-25 years	3.3	2.6

TABLE 2.—*Data on Epicanthus Collected by Drews*

	Ages, Years	Total Number of Children Examined	Epicanthus, First Degree		Epicanthus, Second Degree		Epicanthus, Third Degree	
			Number	Percentage	Number	Percentage	Number	Percenatge
Boys	1 to 14	943	16	1.7	177	18.9	76	8.1
	15 to 25	357	5	1.4	9	2.5	19	5.6
Girls	1 to 14	961	17	1.7	159	16.5	73	3.6
	15 to 25	212	2	0.9	2	0.9	15	6.5

TABLE 3.—*Data on Persons with Epicanthus*

Race	Males	Females
Jewish (Russian)	6	6
Italian	2	3
German	1	1
Scotch	2	0
Irish	0	1
Roumanian	0	1
French	0	1
Total	11	13

No abnormal characteristic of the bridge of the nose was noted in any of these cases.

The ages of the patients varied between 25 and 52 years. No correlation was found between the age and the type of epicanthus.

All the persons were at least of normal intelligence. Eight were college graduates. There was no evidence obtainable of a family history of mongolian idiocy (with, of course, its characteristic epicanthus).

No familial history of this condition could be elicited. In most instances when the person was apprized of the presence of the condition, he said that he had noticed the fold but had thought nothing of it.

A word should be said relative to the proportionately high incidence of epicanthus in Jews and Italians as found in this series. The Jews were all of Russian extraction, and it might be thought that the epicanthus might represent a last faint trace of racial admixture with the Mongolians, a memory of the Tartar invasions of the West. However, a high percentage of the twelve hundred persons examined were Jews; and when the high incidence in Italians is considered, the racial basis must be discounted.

Epicanthus was found in an average of 2 per cent, or 5.5 per cent if Drew's third degree type is considered. This is not at variance with the figures of various European observers. Racial figures have been omitted, as I feel that the series is too small to warrant any valid statistics with respect to this point.

COMMENT

The several classifications and types of epicanthus and its variants have been presented. Although it was formerly believed that epicanthus was a fetal structure, characteristic of all races, histologic studies seem to indicate that there is a distinct difference in the anatomic structures of the eyelids of Mongolian and white persons. However, these studies do not answer the question as to why epicanthus is observed in 2 per cent of the white population. No case of epicanthus in a Caucasian has been studied histologically to my knowledge the findings in which would serve to refute or support such an idea.

There is, on the other hand, good presumptive evidence to support the contention that epicanthus is due to retarded development of the bridge of the nose. The high incidence in children compared with that in adults is an example of this evidence.

It is probably best to consider epicanthus as a product of several interacting factors rather than as due solely to any one factor. In this way so-called hemiepicanthus can be said to have an anatomic basis in the deep insertion of the tendons of the levator palpebralis muscle; epicanthus supraciliaris can be said to be due not only to aberrant tendon fibers but also to an abnormal development of the bridge of the nose; and the other types can be said to be due to variations in the degree of the predominance of any one factor.

Epicanthus inversus might be considered as the lower half of an ordinary epicanthus, the upper half of which, owing to the ptosis, did not or could not develop.[9]

In my opinion the distinction between the vertical and the oblique type of epicanthus is an arbitrary one. The normal occurrence of both types and their variations in Mongolians, as recorded both by Wen [9] and by Gifford,[7] afford good substantiation for this point of view.

CONCLUSIONS

Considered from a structural basis, epicanthus may be classified as follows:

1. Epicanthus supraciliaris
2. Epicanthus palpebralis
3. Epicanthus tarsalis
   First degree—hemiepicanthus (Mongolian eye; *bride mongolique*)
   Second degree
   Third degree—an epicanthic residuum
4. Epicanthus inversus

Epicanthus is due to several factors, the most important of which are an incomplete development of the bridge of the nose and the deep insertion of the tendons of the levator palpebral muscle.

Epicanthus was observed in approximately 2 per cent of adults in the Caucasian race. An additional 3.5 per cent showed residual signs. In none of these persons were any physical or mental stigmas found, and no evidence was obtained to indicate a hereditary basis.

1100 Grand Concourse.

Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

Anatomy and Embryology

THE NERVES OF THE CILIARY BODY AND IRIS. F. ROSSI and V. MOCCHI, Ann. di ottal. e clin. ocul. **63:** 773 (Oct.) 1935.

Rossi and Mocchi studied the nerve distribution in these tissues of the white rat by means of Golgi-stained preparations. They describe the relations of the sensory, vasomotor and pupillomotor nerves, the article being illustrated with schematic drawings. S. R. GIFFORD.

THE NORMAL EPITHELIUM OF THE CONJUNCTIVA. A. KREIKER, Arch. f. Ophth. **134:** 280 (Sept.) 1935.

There is no agreement in the literature as to the type of epithelium that is found in the various parts of the normal conjunctiva. After extensive studies Kreiker has come to the conclusion that the conjunctiva is covered principally by stratified cuboidal epithelium, modified locally under the influence of mechanical or functional factors. A true squamous epithelium and a true cylindric epithelium do not occur in the conjunctiva. A comparison between the conjunctival and the transitional epithelium of the uropoietic organs is instructive.

P. C. KRONFELD.

THE HYALOID CANAL IN MAN AND ANIMALS. O. GASSER, Arch. f. Ophth. **134:** 297 (Nov.) 1935.

On A. Vogt's suggestion, Gasser repeated and modified the original experiments of Stilling and Schwalbe in which a dye, either administered to the posterior pole of the isolated but otherwise intact vitreous or injected into the optic nerve of an enucleated eye, stained only a narrow tubular part of the vitreous which ran from the disk to the lens. Gasser has confirmed this observation and reviews the clinical facts which speak in favor of the presence of a hyaloid canal. P. C. KRONFELD.

Aqueous Humor

EHRLICH-TÜRCK LINE. JORGE MALBRÁN, Arch. de oftal. de Buenos Aires **10:** 734 (Sept.-Oct.) 1935.

Malbrán refers to the greenish vertical line observed in the corneas of rabbits after intravenous injection of fluorescein, which was first described by Ehrlich in 1882 and correctly explained and proved experimentally by Türck in 1906, who attributed it to a deposit in the posterior corneal surface after the establishment of a posterior ascending and an

anterior descending current produced by a difference in temperature in the anterior and posterior portions of the aqueous. He refers also to the experiments of Yosimiti Tutui, who demonstrated its occurrence in some species of animals and not in others (including man) and related its nonoccurrence to different causes: small size of the anterior chamber, existence of substances in the aqueous that prevent formation of the current and low proportion of albumin (e. g., in man). Reference is also made to Lüsi's observation of the line in a certain proportion of normal children and in persons with pathologic conditions in which the proportion of albumin in the aqueous is increased. He then reports a case of spontaneous hemorrhage in the pupillary area, in which on the second day, when the clot commenced to be absorbed, a vertical red line of dot-like formation was observed with the corneal microscope on the posterior corneal surface, which gradually disappeared on absorption of the clot. He considers it as formed by clot particles separated from the larger mass; the day it occurred was exceptionally cold.

C. E. FINLAY.

Biochemistry

THE RETICULO-ENDOTHELIAL SYSTEM OF THE EYE AND DISTURBANCES OF FAT METABOLISM. M. BERTSCH, Arch. d'opht. **52:** 663 (Sept.) 1935.

In this review the conditions considered include xanthelasma and arcus senilis, Gaucher's disease, Niemann-Pick's disease, Tay-Sachs' amaurotic idiocy and Christian-Schüller's disease. The visual apparatus is almost constantly involved. Bertsch points out that in the presence of exophthalmos or oculomotor disturbances (nystagmus and strabismus) in an apathetic infant, or on the detection of amaurosis in an infant idiot with typical changes in the fundus, it is essential not to be content with the most careful ocular examination but always to consider in addition the possibility of a disturbance of lipoid metabolism, especially in any of the conditions referred to.

S. B. MARLOW.

THE CHEMICAL SIGNIFICANCE OF BOWMAN'S AND DESCEMET'S MEMBRANE. Y. SUGITA, Arch. f. Ophth. **134:** 321 (Nov.) 1935.

The anterior halves of ox eyes without their uveal portions and without lenses were tied to the ends of test tubes which were filled with solutions of various crystalloids and colloids. By careful dissection some of the layers of the cornea were removed so that either Descemet's membrane, Bowman's membrane or only stroma was left. Crystalloids and water passed easily through every one of these three membranes, but colloids passed through only the isolated stroma.

P. C. KRONFELD.

Congenital Anomalies

CONSIDERATIONS IN CONNECTION WITH A CASE OF CYCLOPS. J. PÉREZ LLORCA, Arch. de oftal. hispano-am. **35:** 479 (Sept.) 1935.

This is the report of an examination of a cyclopean eye. The eye was defective in some points owing to the fetus having been exhumed.

The latter was born at term, was of normal size and weight, and lived for a few minutes after birth. There was apparently a single eye situated in the middle line, under a large fleshy nasal proboscis implanted under the glabella. The single palpebral fissure had a rhomboidal shape, and next to the inferior angle there were two elevations (rudimentary puncta). There was a single conjunctival sac. The cornea was apparently single, but its greater horizontal diameter with a vertical constriction in the middle line showed it to be in reality double. There were double pupils with two irides, without inferior colobomas. The interior of the eyeball was divided by a vertical partition; there was a single optic nerve, which proceeded from the center of the posterior part of the eyeball; owing to the condition of the fetus the nerve could not be followed into the cranial cavity; on its under surface there was a cystlike formation which communicated with the interior of the eyeball by a double orifice, separated by a vertical partition. The retina, greatly folded and thickened, extended into this cystlike formation; two papillae were found immediately above the communicating holes. There were two lenses. There were two lacrimal glands but no evidence of an excretory lacrimal apparatus. There was a single orbit, formed above by the frontal bone. There was an absence of the bones of the midline of the front part of the base of the skull and of the ascending maxillary and palatine processes. At the base of the proboscis a trace of bony formation was found. Two lateral muscular formations attached to the eyeball and representing the external rectus muscles were found; no other muscular elements in the orbit could be made out. The cerebrum showed no convolutions and absence of a median fissure.

After remarks on cyclopia and on the reserve with which the reported cases with no double elements must be received, the author considers this case as one of fusion of the two originally separate optic vesicles due to nonsufficient separation owing to lack of lateral development of the primary cerebral vesicle, the degree of development in each case depending on the fetal age when the fusion occurred.

C. E. FINLAY.

RING-SHAPED PERIPHERAL THICKENING OF THE CORNEA IN THE REGION OF DESCEMET'S MEMBRANE. G. BIOZZI and L. LUGLI, Arch. f. Ophth. **134**: 287 (Sept.) 1935.

An apparently new picture to be seen by the aid of the slit lamp is described, namely, that of a ring-shaped foldlike protrusion of a part of the peripheral portion of the cornea into the anterior chamber. The ring is usually incomplete; it is about 0.2 mm. wide and located about the same distance axially to the limbus. The parenchyma of the cornea may be slightly opaque in front of this ring. It apparently is a congenital anomaly and is hereditary and familial. Its anatomic basis is either a very pronounced marginal roll (Schwalbe) or the most axially located equatorial fibers of the pectinate ligament of the iris.

P. C. KRONFELD.

Cornea and Sclera

THE KAYSER-FLEISCHER RING IN WILSON'S DISEASE AND MICROCEPHALY. L. BOTHMAN and D. E. ROLF, Am. J. Ophth. **19:** 26 (Jan.) 1936.

Bothman and Rolf describe Wilson's disease, review the literature on it, and discuss the symptoms, pathology and associated phenomena. They report four cases and offer the following comments and conclusions:

"*Comments.*—The occurrence of the Kayser-Fleischer ring is not so rare as has been commonly believed, for the four cases here recorded were seen within a period of nine months.

"In the classical description of Wilson's disease, there is involvement of the liver, yet in the three unquestioned cases of this condition here recorded none showed either an enlarged liver or disturbed liver function. This is in accordance with most of the cases now on record in the literature. In the fourth case also, the liver was of normal size.

"Case 2 is of unusual interest because of the presence of the Kayser-Fleischer ring in a child showing microcephaly but as yet no evidence of extrapyramidal disease. The patient is only eight years old and may still develop a true Wilson's symptom complex. Her brother (case 1) began to develop symptoms at 15½ years of age. In no previous report has the Kayser-Fleischer ring been described in so young an individual. Its presence at this age may indicate that it does occur early and escapes notice until after the pronounced extrapyramidal signs lead to a diagnosis of lenticular degeneration.

"*Conclusions.*—1. Three fairly typical cases of lenticular degeneration with Kayser-Fleischer ring are described.

"2. Signs of pyramidal disease and microcephaly together with a typical Kayser-Fleischer ring are described as occurring in the younger sister of one of the patients with true Wilson's disease."

W. S. REESE.

VARICELLA OF THE CORNEA. R. PICKARD, Brit. J. Ophth. **20:** 15 (Jan.) 1936.

A boy 10 years of age was the last of four children in a family to contract varicella. Three weeks later one of his eyes became irritable. Two days after this the cornea showed a central gray opacity, well defined, circular, with a crenate edge, and, in diameter, equal to one quarter of the cornea. The pupil was sluggish. The biomicroscope showed a swelling of the cornea in the region of the opacity, bulging toward the anterior chamber. The section of the cornea was yellowish and mottled. On the posterior surface of the cornea was a flat brownish-yellow mass having a free spongy surface. The corneal nerves were not thickened. The curve of the cornea was normal. There was full recovery of vision.

The aspects observed with the slit lamp suggest that the keratitis was caused by an organism having a limited growth the course of which soon came to an end. The simplest explanation of the condition is that

it was an eruption of varicella, occurring late because of the special structure of the cornea—a nonvascular dense tissue which offers special difficulties to the transit of the virus.

W. ZENTMAYER.

TUBERCULOUS EPITHELIAL KERATITIS. B. DIMISSIANOS, Arch. d'opht. **52**: 499 (July) 1935.

A very rare case of localized superficial corneal disease is described. The condition is characterized by chronic changes in the epithelium in the form of flattened ridges in the superior portion of the cornea. Because of these streaks or cords the name "tendinous keratitis" seems appropriate, since in the classification of corneal disease the form and distribution of the process are usually taken into consideration. As a result of the extensive laboratory work done in this case it is believed that the condition is tuberculous in origin. Dimissianos suggests that probably it is due to the action of the toxin of the tubercle bacillus and is inflammatory, the chronicity and torpidity being such that it resembles clinically a corneal dystrophy.

S. B. MARLOW.

DEGENERATION OF THE CORNEA OF THE NODULAR TYPE OF GROENOW: ITS RELATION TO LATTICE KERATITIS. P. BONNET and J. BUSSY, Bull. Soc. d'opht. de Paris, November 1935, p. 715.

Two sisters had bilateral corneal degeneration of the Groenow type indistinguishable from the grill or lattice keratitis described by Dimmer and Haab. An uncle on their mother's side was known to have the same disorder. The nodules were disseminated in great numbers in the median region of the cornea. In addition, certain changes in the periphery showed a relation to the grill-like keratitis. Small dots seemed suspended under an edema on the nerve fibers. These dots were very refractile. The findings in the three patients suggest to the authors a relationship between the two types of keratitis.

L. L. MAYER.

FAMILIAL MICROCORNEA. G. VON GROLMAN, Arch. de oftal. de Buenos Aires **10**: 741 (Sept.-Oct.) 1935.

Von Grolman observed pronounced pure microcornea in a brother and sister of 42 and 35 years. In childhood they had good sight, complicated in the brother with cataract and in the sister with high myopia (over 20 diopters), the eyes being otherwise normal.

He reports his examination of the patients in detail and reviews the statistics on malformations of this and allied types, eliminating the possibilities of confusion with microphthalmos, cornea plana and pseudomicrocornea.

C. E. FINLAY.

DISCIFORM KERATITIS FOLLOWING DENDRIFORM KERATITIS. F. HAMBURGER, Klin. Monatsbl. f. Augenh. **94:** 382 (March) 1935.

After a typical attack of dendriform keratitis accompanying herpes labialis in a man aged 31 had healed, a deep-seated corneal infiltration developed under increasing symptoms of irritation. This infiltration consolidated gradually and presented a form characteristic of disciform keratitis. This patient with disciform keratitis arising directly from a superficial herpetic eruption was presented by Hamburger before the Ophthalmologic Society of Vienna on Dec. 10, 1934.

K. L. STOLL.

PARTIAL CORNEAL TRANSPLANTATION. M. A. STERNBERG, Sovet. vestnik oftal. **7:** 637, 1935.

Sternberg reports four leukomas of various origin in which he performed corneal transplantation. He used a trephine 4.5 mm. in diameter for both the donor's and the recipient's cornea. Three transplants were taken from eyes enucleated because of absolute glaucoma and one from an eye enucleated because of iridocyclitis. All transplants "took," but only two remained transparent during the period of observation of ten months. A conjunctival flap prepared after the method of Filatov was used in each transplantation. In none of the cases was there prolapse of the vitreous. Detailed histories are appended. His conclusions are: 1. Further simplification of the technic of corneal transplantation is desirable. 2. Transplantation of the cornea is simple, and it should be undertaken by all ophthalmologists who work far away from large centers.

O. SITCHEVSKA.

General Diseases

A CASE OF CHLOROSIS WITH OCULAR COMPLICATIONS. J. B. HAMILTON, Brit. J. Ophth. **20:** 18 (Jan.) 1936.

The patient was a married woman aged 33. Hamilton states that indisputably she had chlorosis. There was bilateral papilledema of 3 diopters of swelling. A macular star was present, but there was no retinal hemorrhage. There was paresis of the external rectus muscle. Under intensive iron therapy all the ocular symptoms disappeared.

W. ZENTMAYER.

OCULAR TUBERCULOSIS AND ITS TREATMENT WITH SPENGLER'S IMMUNE BODIES. GIMÉNEZ CÁNOVAS, Arch. de oftal. hispano-am. **35:** 533 (Oct.) 1935.

The author divides ocular tuberculosis into classic and nonclassic forms, including in the latter those depending on hypersensibility to the bacilli. In these forms some visceral immunity is present. They comprise the so-called scrofulous disorders: blepharitis, sty, eczema, phlyctenular ophthalmia, follicular conjunctivitis, relapsing vitreous hemorrhages and some chronic choroidal diseases.

In connection with the defensive processes to which these disorders give rise, Spengler attributes a predominant influence to the red blood cells and the function of the hematopoietic organs. The author reviews at some length Spengler's theories, investigations and experiments and the production of the Spengler immune bodies, which are a slightly acid extract of the blood of animals immunized with the "bacillus humano-longus," detailing how it is obtained, the dilutions made and the method of employment. The Spengler immune bodies are neither tuberculins nor serums but participate in the nature of both (lysins and antitoxins), their use being followed by some local and general reaction with beneficial results. They can be administered hypodermically, by mouth and by inunction. The treatment should be commenced with the higher dilutions. A satisfactory result manifests itself by a feeling of well-being followed by increase in weight, lowering of the temperature, reduction of the pulse rate and improvement in the local symptoms.

The effect of their use is especially marked in the cases belonging to the second group. In the other cases it is not so marked, and the production of beneficial results is slower.

C. E. FINLAY.

General Pathology

SECONDARY INTRA-OCULAR GLIOSIS. C. DEJEAN, Arch. d'opht. **52:** 863 (Dec.) 1935.

The reactions following injury to the nerve tissue within the eye are: (1) a reaction of leukocytes derived from the blood vessels; (2) a reaction of the neuroglial cells with mobilization and phagocytosis; (3) an elimination of débris, and (4) a proliferation and gliosis. These four phases are separately discussed, the last in great detail with illustrations. The consideration of the subject leads to the conclusion that cicatricial neuroglial proliferation is more common than is generally thought and that the ciliary retina also takes part in it. The reactions are quite like those in other nerve tissue, their appearance and extent depending on the duration of the condition. The persistence of foreign bodies and the products of disintegration favor glial proliferation.

S. B. MARLOW.

Methods of Examination

A SIMPLE DEVICE FOR MEASURING STEREOPSIS. M. DAVIDSON, Am. J. Ophth. **18:** 356 (April) 1935.

Davidson uses an octagonal card 20 cm. in diameter into which he sticks white veil pins. These are available on the market in diameters of from 2.5 to 4.5 mm. with stems from 3 to 5 cm. long. The test objects are 0, 14, 28, 42 and 56 mm. from the card. The card can be revolved so as to change the position of the test objects. The test is first made at 6 meters, the patient being asked to pick out the object nearest him. If he succeeds in naming them in order, he has a stereoscopic acuity of 5 seconds of arc. If he fails at 6 meters, the examination is repeated at 4, 3 and 2 meters.

W. S. REESE.

Ocular Muscles

STRABISMUS IN CHILDREN CORRECTED BY REFRACTION ALONE. G. P. GUIBOR, Am. J. Ophth. **18:** 944 (Oct.) 1935.

Guibor records the following conclusions:

"1. A report is made of 185 patients with confirmed nonparalytic squint, for whom only glasses were prescribed and who did not have the benefit of occlusion, atropinization, nor fusion training. Of these patients 63.43 per cent were unimproved, 13 per cent were improved and 23.6 per cent had no squint with glasses (nine patients or 0.4 per cent had no squint when glasses were removed).

"2. A high degree of squint and amblyopia have the greatest influence in retarding recovery from squint.

"3. Out of 26 patients, 5 with alternating squint recovered with the use of glasses; of these, three could fuse with depth effect, and two had poor fusion of flat objects.

"4. Patients in the younger groups (2 to 4 years) recover more easily and in greater numbers than do those in the older-age groups.

"5. Patients with the accommodative type of squint recover most readily by correction of the refractive errors." W. S. REESE.

THE TRAUMATIC OPHTHALMOPLEGIAS AS A WORKMEN'S-COMPENSATION PROBLEM. M. DAVIDSON, Am. J. Ophth. **18:** 1030 (Nov.) 1935.

Davidson regards the charting of diplopia for the purposes of workmen's compensation as very unsatisfactory. Modifying the Perlia test, he has the patient touch a veil pin held in the examiner's hand with another held in the patient's own hand. This is done before a tangent screen at intervals of 5 degrees in the entire normal field of binocular stereopsis, that is, to a radius of 30 degrees, the results being recorded on a tangent screen record form. The clinical observations in seventy-one cases of traumatic ophthalmoplegia are given.

W. S. REESE.

Orbit, Eyeball and Accessory Sinuses

EYESOCKET RECONSTRUCTION NECESSITATED BY EXTRAOCULAR MYOSITIS ASSOCIATED WITH THYROID DISEASE. G. B. O'CONNOR and G. W. PIERCE, Am. J. Ophth. **18:** 51 (Jan.) 1935.

O'Connor and Pierce report the case of a man, aged 60, whose right eye had been removed and who complained of being unable to wear a prosthesis. He had had two operations on the thyroid gland. The right socket was found to contain a bulky soft mass which proved at operation to be hypertrophied extrinsic eye muscle.

W. S. REESE.

THE PATHOGENESIS OF SOME INTRA-OCULAR OSSEOUS TISSUE: TRUE METAPLASIA IN THE EYE. H. D. LAMB, Am. J. Ophth. **18:** 409 (May) 1935.

Lamb gives the following summary: "True metaplasia, or the formation of connective tissue from epithelium of ectodermal origin, occurs in the human eyeball. The anatomic findings are reported for several eyeballs, in which could be observed the various stages in the change to fibroblasts from pigmented epithelial cells of the ciliary body and of the retina. In regard to the unpigmented ciliary epithelium, no attempt was made here to study its possible participation in this metaplasia. Its unpigmented cells were obviously much more difficult to follow through any changes. The connective tissue, derived through hyperplasia of the pigmented ciliary and pigmented retinal epithelia, was always dense and homogeneous, having few fibroblasts and few blood vessels. This connective tissue occurred in layers along the inner surface of the ciliary body under the unpigmented epithelium, along the inner surface of the choroid and in globular masses within the detached retina. In the writer's cases, proliferation of the pigment epithelium and the production of connective tissue from it is encountered more frequently at and near the ora serrata. Unless the connective tissue is of long standing, it is always associated with numerous groups of pigmented epithelial cells, lying within or around the connective tissue. The participation of the choroid and vascular layer of the ciliary body in this metaplasia apparently consists only in furnishing, in the vicinity of the dense connective tissue, a good supply of blood; the latter, as above mentioned, is one of Poscharissky's essential factors for the development of bone. The choroid and ciliary body in all the cases described were atrophic but may show infiltration with small round cells in a focal manner, adjacent to the areas of metaplasia. The lamina vitrea was generally intact but no claim is made for its complete integrity. For that matter, where the retina is undetached, it would not be impossible for fibroblasts to come from around the retinal blood vessels. The claim for metaplasia, however, is made solely upon a study of the individual pigmented epithelial cells.

"The production of bone in this dense, homogeneous connective tissue adjacent to the good blood supply in the choroid occurred in the case of one eye of this series with the apparent formation of the preosseous connective tissue mold of Leriche and Policard. In another case, spicules of bone developed at various places in areas of this connective tissue, showing a primary diffuse deposit with lime salts; the latter method will recall Poscharissky's essential factors again. Osseous tissue in the human eyeball can after a long time form true bone marrow with numerous bone-marrow cells." W. S. REESE.

Physiology

THE OCULOCARDIAC REFLEX: REPORT OF A CASE EXHIBITING A MARKED REACTION FOLLOWING ENUCLEATION OF THE EYEBALL. J. H. BAILEY, Am. J. Ophth. **18:** 22 (Jan.) 1935.

Bailey reports the case of a carpenter, aged 31, who was struck in the left eye while hammering a brick in January 1927. In October

1932 it became necessary to enucleate the eye, and this was done under local anesthesia. The bleeding that followed cutting of the optic nerve could not be stopped except by a water-tight continuous suture in the conjunctiva. The sutured conjunctiva protruded for an appreciable distance beyond the interpalpebral fissure. When the toilet of the wound was being completed the patient complained of feeling faint and became pale, covered with perspiration and nauseated. His pulse rate was 65 and became progressively slower until it reached 30. Bailey concluded that this was an exaggerated oculocardiac reflex caused by intra-orbital pressure from the hemorrhage. W. S. REESE.

CONVERGENCE AND JUDGMENT OF DISTANCE. R. GRIMM, Arch. f. Ophth. **134:** 359 (Nov.) 1935.

It is generally believed that egocentric judgment of distances based on the degree of convergence of the eyes is uncertain and inaccurate. Just how accurate or inaccurate the information is which is supplied by the deep sensibility of the muscles of convergence is not definitely known. Grimm suggests a new approach, namely, that of comparing the smallest impulses or, practically, the smallest possible movements of the convergence mechanism with those of the reaching mechanism, i. e., the arm. The smallest possible convergence movement is about 6 arc minutes. At a distance of 180 cm. the smallest possible "step" of convergence moves the binocular point of fixation about 18 cm. nearer or farther away. Judgment of distance at that range (180 cm.) seems to be more accurate than that at 18 cm., or 10 per cent of that range. At this range, therefore, the judgment of distance is probably not based on the smallest possible impulses. At distances of from 30 to 60 cm. the smallest convergence movement as well as the "shortest stretch" for movements of the unsupported arm is about 2 cm. Here the smallest impulses move the binocular point of fixation and the organ of reach to the same extent. At ranges under 30 cm. the steps of the convergence movement become much finer than those of the arm. Stereoscopic perception of distance is, of course, much too fine for the organ of reach.

The influence of the convergence of the eyes on the judgment of distance is also clearly evidenced by experiments in which two identical objects are used with the lines of fixation of the two eyes crossing each other between the objects and the observer. The observer then usually expresses his sensations by reporting changes in the size of the objects. In reality he expresses a faulty judgment of distance under the influence of the excessive (for the particular distance) convergence. See the previous papers on convergence micropsia by the same author (*Arch. f. Ophth.* **130:** 339, 1933; **133:** 121, 1934). P. C. KRONFELD.

Refraction and Accommodation

MYOPIA AND NEARWORK. H. LIPSCHUTZ, Brit. J. Ophth. **19:** 611 (Nov.) 1935.

Stating that most theories advanced to explain the bad influence of near work on myopia have been refuted, Lipschutz deals with the congestion of the venous outflow from the eye and orbit in the stooping

posture. It can be assumed that the postural change in the arterial afflux does not play an important rôle. In lowering the head there is only a very transient increase in the hemostatic pressure in the internal carotid artery and its branches, as a rise of pressure in the carotid sinus is answered by a dilatation of the arterioles of the rest of the body, with the result that the inflow into the internal carotid artery is diminished, compensating or overcompensating the initial rise of the pressure. On the other hand, in bending the neck a direct compression of the carotid sinus may occur. This will increase the venous congestion in a much higher degree than it throttles down the arterial flow or causes response to the stimulation of the carotid sinus. The author has observed a case of intermittent exophthalmos in which the exophthalmos readily came on in the bent position of the head and was much enhanced by pressing on the region of the carotid bifurcation.

W. ZENTMAYER.

FUCHS' SPOT IN MYOPIA. M. ALVAREZ CASTELAO and J. DE LA TORRIENTE RIVAS, Arch. de oftal. hispano-am. **35:** 617 (Dec.) 1935.

After describing what is known as Fuchs' (black) spot in myopia, the authors give a review of the current views as to its cause and the pathologic observations in the only case in which such observations have been reported (Lehmus) (nonparticipation of the choroid, proliferation of the retinal pigment at the macula with atrophy of the macula surrounding it, and a noncellular gelatinous exudate over the proliferated pigment, to which the overlying retinal layers were adherent, forming a pronounced projection into the interior of the globe). They then report ten cases, illustrating nine with photographs of the fundi. In three of the cases photographs made with both ordinary and infrared illumination are shown. They consider that Fuchs' spot should be considered as a myopic lesion attributable to a glial proliferation which later becomes pigmented, and that it shows no preference for sex, age or a particular eye. They confirm Fuchs' observation that it is more commonly observed in association with myopia of a moderate degree.

C. E. FINLAY.

Retina and Optic Nerve

SIMULTANEOUS CLOSURE OF ALL THE CENTRAL RETINAL VESSELS. M. B. BENDER, Am. J. Ophth. **18:** 148 (Feb.) 1935.

A woman, aged 32, sensed swelling and numbness in the right side of the face an hour after the extraction of four teeth. The next day she had headache, diplopia and transient blurring of vision. In the evening a physician found an injected pharynx and a temperature of 101 F., and made a diagnosis of influenza, of which there was an epidemic. The next day, thirty-six hours after the extraction of the teeth, the vision in the right eye was reduced to counting fingers at 1 foot (33 cm.) and that in the left eye to total blindness. Ophthalmoscopy revealed thrombosis of the central retinal vein in each eye. About six weeks later both nerve heads were white, with indistinct outlines, and there was complete absence of blood vessels in the fundus except for a few whitish streaks radiating from the nerve heads.

W. S. REESE.

CLINICAL AND GENEALOGICAL NOTES ON A CASE OF ATYPICAL RETINITIS PIGMENTOSA ASSOCIATED WITH OBESITY, POLYDACTYLY, HYPOGENITALISM, AND MENTAL RETARDATION (THE LAURENCE-MOON-BIEDL SYNDROME). L. H. SAVIN, Brit. J. Ophth. **19:** 597 (Nov.) 1935.

Savin's patient, a youth aged 17 years, exhibited the syndrome of obesity, hypogenitalism, mental retardation and pigmentary disturbance described by Laurence and Moon. There was no paraplegia. Scars indicated the removal of supernumerary digits of both hands and feet.

Although details are not complete it does not seem unwarranted to assume that the patient's deceased brother and sister suffered from the Laurence-Moon-Biedl syndrome with polydactyly.

The article is illustrated. W. ZENTMAYER.

THE EVOLUTION OF ALTERATIONS OF THE MACULA IN ANGIOID STREAKS OF THE RETINA: ITS ANALOGY TO THE PROCESS OF SENILE MACULAR EXUDATIVE RETINITIS. P. BONNET, Arch. d'opht. **52:** 225 (April) 1935.

This report is accompanied by a series of illustrations representing the changes which occurred at the macula in a case of angioid streaks of the retina which was followed at regular intervals for a period of eighteen months. When first seen, the patient had had a disturbance of vision for three months which was characterized by a central scotoma. The whole process, which was characterized by the sudden appearance of a macular exudate and the progressive increase of the exudate and of its hemorrhagic border, resembled senile macular exudative retinitis. The disease lasted about a year. Vision remained unchanged. The scotoma underwent some slight variations.

Few observations have been made on the course of development in cases of this type. From a review of the reports which have appeared Bonnet suggests that the finely pigmented and wrinkled appearance of the macula probably represents the initial stage of the disease, and that the pigmented appearance of the macula can precede the occurrence of angioid streaks of the retina. S. B. MARLOW.

THE PATHOLOGIC ANATOMY OF IDIOPATHIC DETACHMENT OF THE RETINA. P. VEIL, M. A. DOLLFUS and DESVIGNES, Arch. d'opht. **52:** 307 (May) 1935.

The pathology of idiopathic detachment of the retina as it has been presented in the literature is reviewed. The opinion expressed by Gonin that macroscopic examination has been neglected too much in favor of microscopic study is concurred in. Gonin has emphasized especially (1) retraction of the vitreous, (2) folds of the retina and (3) easily observed tears. Microscopic study of the retina has shown that the changes in it consist mainly in degeneration and atrophy of the nerve layers, especially in the area of the detachment or of the tears. The changes in the choroid consist in congestion in recent cases and atrophy in old. The vitreous in early cases has shown only slight changes, whereas in old cases the changes are extensive. The subretinal fluid in recent

cases is clear and limpid, its albuminous content is not elevated, and its density is thin, so that it is almost identical with normal vitreous. As time passes it undergoes degenerative changes. The authors present the detailed macroscopic and microscopic study of an eye removed after death, twenty-nine days after the beginning of the detachment. This case is similar to others of recent origin. The rods and cones showed little change, even though the detachment had been of about one month's duration. The authors point out that many more cases must be examined before any deductions can be drawn. Very few have been reported up to the present time.

S. B. MARLOW.

THE RELATION BETWEEN DETERIORATION OF THE VITREOUS AND THE DEVELOPMENT OF RETINAL TEARS. M. BAURMANN, Arch. f. Ophth. **134:** 201 (Sept.) 1935.

The method described previously (at the meeting of the German Ophthalmological Society in Leipzig in 1932) for ultramicroscopic examination of the vitreous in situ has been applied to four human eyes (two removed from the cadaver and two enucleated during life because of tumor). The vitreous showed the normal ultramicroscopic picture in some parts and signs of deterioration, i. e., cavities with liquid amorphous contents, in others. Similar changes were present in the apparently normal eye of a boy aged 16, but with increasing age they seemed to increase in severity and extent. In the numerous eyes of animals which Baurmann had examined by the same method he had not noticed any comparable changes, perhaps because these animals were absolutely and relatively younger than the youngest human being.

He now discusses the probable influence of this deterioration of the vitreous on the retina during movements of the eye. If the whole vitreous is in the normal gel condition it must move with the coats of the eye and thus exert a considerable pull on the part of the retina and ciliary body to which it is firmly adherent. This part, the anatomic base of the vitreous, is very large, so that the pull per square millimeter is probably only slight. If the whole vitreous is completely liquefied there is no pull on the retina. If most of the vitreous is liquefied but small bits of vitreous gel remain intact and attached to the retina, then, according to Baurmann's calculations, the pulling force exerted per square millimeter of retina is considerable and probably sufficient to produce a retinal tear in the constantly moving eye.

P. C. KRONFELD.

METASTASES OF A CARCINOMA OF THE MAMMA IN THE OPTIC NERVE: REPORT OF A CASE. H. ORTH, Klin. Monatsbl. f. Augenh. **94:** 612 (May) 1935.

A woman aged 49 had had the right mamma and the axillary glands removed in 1933; metastases were found in the glands. The left mamma had to be amputated in 1934; the glands were not involved. Shortly after the second operation the patient complained of visual disturbances in both eyes. Numerous small pigment spots and gray foci were observed temporal from the disk of the right eye, chiefly in the area of the macula and about 6 to 7 disk diameters temporal from the disk.

The vision of the left eye was reduced by a choked disk, which was surrounded by numerous fine radial capillaries and blood extravasations. A white tumor protruded from the site of the funnel of the disk, hiding the entrance of the retinal vessels; it had an uneven surface and was covered by a net of minute capillaries. Two other metastases were observed, one in the upper nasal third of the disk and the other in the area of the macula. The vision after correction of myopia of a high degree was 5/15 in the right eye and 5/7.5 in the left. The vision in the left eye was lost suddenly and completely three months later as a consequence of thrombosis with edema and hemorrhages in the retina. The three metastases were still visible; the retina had a yellowish hue, and the macula appeared red. No metastases were noted in the right eye, in which the pigmentation in the fundus was supposed to be due to toxic influences.

K. L. Stoll.

Therapeutic Action of Retrobulbar Injections of Atropine on Embolism of the Central Retinal Artery. S. I. Borokhovitch, Sovet. vestnik oftal. **7**: 149, 1935.

Four cases of embolism of the central retinal artery in which retrobulbar injections of a 1:1,000 solution of atropine restored the vision are reported. Three of the patients had cardiac disease. The injections were given every other day until six or seven had been given; the initial dose was 0.4 cc., which was increased to 1 cc. The visual fields and vision were improved in three cases from ability to count fingers to normal. In one patient, who suffered from sclerosis of the blood vessels, the injections were of no avail.

The therapeutic effect might have been produced either through the dilation of the blood vessels with the embolus being pushed into the smaller vessels or through the formation of a collateral blood supply between the retina and the choroid for the nutrition of the former.

O. Sitchevska.

Trachoma

Trachoma as an Endemic Disease in Egypt. F. Massoud, Am. J. Ophth. **18**: 952 (Oct.) 1935.

Massoud stresses the importance of internal or constitutional factors in the causation of trachoma. He reaches the following conclusions:

"1. Trachoma as an endemic disease is acquired in early infancy.

"2. Faults in diet and personal hygiene added to local irritation are important elements in its causation.

"3. For prophylaxis, local antitrachoma centers are of use."

W. S. Reese.

The Laws of True Trachomas. C. Pascheff, Arch. d'opht. **52**: 301 (May) 1935.

From a consideration of these laws, Pascheff points out that true trachoma is not a simple inflammatory process with exudative infiltra-

tion and ordinary proliferation but a lymphoblasto-endothelial germination which develops even in the cornea and gives rise to follicular vegetations with a tendency to confluence and degeneration. The five laws on which this belief is based are: 1. True trachoma does not exist without germinal centers or follicles. 2. The trachoma follicle is a lymphoblasto-endothelial germination, confluent or follicular. 3. True trachoma develops in the most vascular parts of the conjunctiva: the culdesac and the limbus. 4. True trachoma degenerates and ends by cicatrization or hyalinization. 5. True trachoma can recur after expression but always with the formation of follicles. These conditions indicate that trachoma is a special hyperplasia of the lymphatic structures of the conjunctiva, a lymphadenoid hyperplasia sui generis of the conjunctiva.

S. B. MARLOW.

A GERM WITH THE CHARACTERISTICS OF A RICKETTSIA (RICKETTSIA TRACHOMATIS) IN TRACHOMATOUS TISSUE. A. BUSACCA, Arch. d'opht. **52:** 567 (Aug.) 1935.

Busacca summarizes the results of the report he made on this subject at the International Congress of Ophthalmology in Madrid in 1933, which have so far been overlooked by Cuénod, Thygeson and others. He has demonstrated in the epithelial and granulation tissue, including nodules, intracellular and extracellular bodies which he has considered rickettsias because of their size and morphologic aspects. The methods used in studying them and the controls are referred to. He believes that the Giemsa method is the best. He suggests that Cuénod and Thygeson describe the same organism. He has been unable to find this organism in any control tissue except that involved in Hodgkin's disease.

S. B. MARLOW.

Tumors

THYROID CARCINOMA WITH METASTASIS IN THE CILIARY BODY. H. C. ORR and I. L. JOHNSTONE, Brit. J. Ophth. **19:** 593 (Nov.) 1935.

The patient was a coal miner 16 years of age. There was clinical evidence of a tumor of the ciliary body on the temporal side of the eyeball. The pathologic examination of the excised eye showed the outer two-thirds to be occupied by a carcinomatous mass. The cells composing the growth were columnar and formed multiple papillae. In the majority of the papillae the central core was slender, often edematous, and consisted of young fibrous tissue with new-formed blood vessels. Fine pigment was scattered throughout the growth. In one of the papillae the columnar cells appeared to be continuous with the outer layer of cells covering the normal ciliary processes. In the choroid immediately behind the growth were massive hemorrhages. In the thyroid area of the neck there was a hard fixed lump which had been present for at least eight years. The growth was removed and found to be a columnar cell carcinoma.

Orr and Johnstone believe the case to be rare if not unique.

The article is illustrated.

W. ZENTMAYER.

A Neuro-Epithelioma of the Retina. R. Perrin and Noel, Arch. d'opht. **52:** 814 (Nov.) 1935.

The patient's age is not given. The affected eye had been blind for two years, the patient coming under the authors' observation because of severe acute glaucoma. This finally required enucleation of the eye. Histologic examination revealed a neuro-epithelioma in parts of which typical rosettes were present. The article is illustrated with drawings of the rosettes.

S. B. Marlow.

Hemangioblastic Sarcoma of the Eyelid: Systematic Division of the Angioblastic Tumors. F. Rintelen, Klin. Monatsbl. f. Augenh. **94:** 463 (April) 1935.

Rintelen reports a case of hemangiosarcoma endotheliomatosum in a girl aged 14. Four months prior to her admission to the hospital nothing could be seen on the lower lid of the left eye; three months prior, a dark red wart the size of a pinhead could be seen. On admission the tumor had a base 8 mm. in diameter and a height of 1 cm. It could not be moved over its layer. Some of its cells greatly resembled those of a spindle cell sarcoma. Rintelen therefore considered it malignant.

In the second chapter of his paper Rintelen discusses the unsatisfactory classification and confusing nomenclature of these tumors. He proposes this division:

1. Homeotypical forms: (*a*) angioma simplex, (*b*) angioma cavernosum and (*c*) angioma endotheliomatosum. These are benign.

2. Heterotypical forms: (*a*) angiosarcoma simplex, (*b*) angiosarcoma cavernosum and (*c*) angiosarcoma endotheliomatosum. These are malignant.

Both types may originate (1) from lymph vessel tissue and (2) from blood vessel tissue.

Incidentally Rintelen rejects the synonym "telangiectasia" for "simple angioma," which designates a frequently congenital new formation of blood vessels; telangiectasia is an acquired enlargement of normally existing vessels. The term "naevus flammeus" should be used in ophthalmology only in reference to those nevi in which the characteristic nevus cells composing these tumors have been found histologically.

K. L. Stoll.

Therapeutics

Use of Sclerosing Solutions in Ophthalmic Therapeutics. M. F. Weymann, Am. J. Ophth. **18:** 323 (April) 1935.

Weymann reviews the literature on sclerosing solutions and reports three cases in which he used a solution of quinine and ethyl carbamate (quinine hydrochloride, 4 parts; ethyl carbamate, 2 parts, and water, 30 parts) with very good results. He concluded from experiments on rabbits that the injection of the full strength solution of quinine and ethyl carbamate into the orbit should not be undertaken lightly. He believes such solutions are of value but should be considered dangerous when other and simpler therapeutic measures will suffice.

W. S. Reese.

TREATMENT OF THE HUMAN EYE WITH ULTRASHORT WAVES. J. F. DE DECKER and J. ARENDT, Klin. Monatsbl. f. Augenh. **95:** 462 (Oct.) 1935.

De Decker, an oculist, and Arendt, a roentgenologist, report their results in the treatment of human eyes with ultrashort waves. A short description is given of the apparatus, the duration of the treatments and the dosage of current. Seven patients with ocular disease were treated; four had keratitis of herpetic provenience, one herpes zoster with deposits on Descemet's membrane, one scleritis, one catarrhal conjunctivitis and one interstitial keratitis. The authors arrived at the following conclusions: 1. Treatment with ultrashort waves of a certain length is indicated in all ocular diseases in which heat in any form is therapeutically applicable. This treatment is superior to other methods on account of its even penetrating and curative action and the handy method of application. 2. The ultrashort waves yield especially favorable results in herpetic disorders of the cornea. Their action is superior to that of diathermy. 3. Resorption of corneal opacities of long standing is considerably furthered.

No untoward action was observed except in the sixth case. It concerned a 70 year old woman with scleritis and nodular thickening of the entire nasal side of the sclera. During the second set of four treatments the temporal portion of the sclera became irritated, but no nodules formed; the irritation disappeared promptly. No further treatments were contemplated when the patient complained of headache and vertigo, which seemed to be caused by considerable cerebral arteriosclerosis. This disease may contraindicate treatment with ultrashort waves. Similar complications may be avoided in the future by correct selection of patients and by exact timing of exposures. K. L. STOLL.

Society Transactions

EDITED BY DR. JOHN HERBERT WAITE

FRENCH OPHTHALMOLOGICAL SOCIETY

Forty-Ninth Congress, Paris, May 11-15, 1936

TRANSLATION BY PERCY FRIDENBERG, M.D., NEW YORK

First Session, May 11

EXPERIMENTAL STUDY OF TRACHOMA. DR. CUÉNOD and DR. NATAF, Tunis.

Bacteriologic and histologic investigations lead us to believe that the virus of trachoma is related to Rickettsia or is carried by members of that group. Inoculations of the virus of trachoma into the intestines of healthy fleas were followed by the development of cultures of Rickettsia. Starting with fleas thus inoculated, we were able to produce typical experimental trachoma in several monkeys. It appears that although the flea does not necessarily transmit trachoma it may be a veritable storehouse of the virus.

TREATMENT OF TRACHOMA IN INFANTS. DR. ZACHERT, Warsaw, Poland.

No abstract was submitted.

REPLACEMENT OF DISEASED TARSUS. DR. PAGANI, Milan, Italy.

No abstract was submitted.

HISTOLOGIC DIAGNOSIS AND TREATMENT OF GLANDULAR EPITHELIOMA OF THE EYELID (Lantern Slides). DR. TOULANT and DR. MORARD, Algiers.

Tumors of this type are rare. Statistics of the treatment of epithelioma of the eyelid with radiant energy do not mention this variety. Only seventy-eight cases have been found recorded on careful search of the literature.

CASE 1.—A woman of 60 had on the left upper eyelid an ulcerating, proliferating tumor, which had invaded the entire lid. Five applications of radiotherapy caused the neoplasm to melt away rapidly with complete restoration of the lid to normal. There has been no recurrence for a year. Histologic examination showed an epithelioma undergoing sebaceous degeneration.

CASE 2.—A woman of 60 had a tumor the size of a small nut under the conjunctiva of the right upper eyelid. It was removed by V-shaped excision, and there was no recurrence after ten months. Staining with scarlet red (after freezing) revealed an epithelioma with sebaceous

degeneration, originating in the meibomian glands. In our paper we review the various methods of treatment and advise radiotherapy for advanced growths, the operative removal of which would necessitate plastic procedures for repair, reserving surgical treatment for tumors of small size.

Ocular Pemphigus (Lantern Slides). Dr. Tillé, Paris; Dr. Chapuis, Niort, and Dr. Bory, Paris.

We have made a study of subacute malignant pemphigus of the conjunctiva with progressive essential shrinkage of the conjunctiva in two patients, one of whom presented involvement of the soft palate, and the other, ichthyosiform hyperkeratitis. The study is based on data derived from interferometry and from bacteriologic and histologic examinations. In one patient the shrinkage of the conjunctiva was in the initial stage. There was buccopharyngeal involvement but the contents of the bullae were sterile and not toxic for rabbits. The general condition of this patient was very bad. He had suffered acute endocrine shock. There was no pemphigus of the skin or fragility of the epidermis (Nikolsky's sign). The other patient also presented progressive shrinkage of the conjunctiva, but in the final stage. It accompanied an ichthyosiform hyperkeratosis (Darier) or ichthyosiform erythroderma (Brocq) with ichthyosis of the trunk and extremities reaching to the buttocks but not involving the axillae. There were also lesions of the nails, hyperkeratosis of the palms and soles and similar fissuring lesions of the backs of the hands, and of the face, with dermic atrophy and telangiectasis. This patient's general condition was good, and there was no endocrine imbalance. We believe that this ocular syndrome with well individualized retraction of the conjunctiva (von Graefe) has evident relations with the group of pemphigus as a whole and certain affiliated groups such as those mentioned and the dermatitis of Duhring.

Epithelioma of the Lacrimal Sac (Lantern Slides). Dr. Genet, Lyons.

No abstract was submitted.

Danger of Injecting Caustic Substances in the Treatment of Diseases of the Lacrimal Gland. Dr. Villard, Montpellier.

Following a false passage with or without previous probing a certain quantity of the caustic fluid (silver nitrate, zinc sulfate, alum, mercury bichloride, lead subacetate or chromic acid) may collect outside the tear passages and diffuse into the orbit. Here it may give rise to the most serious complications such as orbital cellulitis with consequent atrophy of the optic nerve or even fatal meningitis. To avoid such an accident one should abstain from probing before injecting fluid into the sac and make sure of sufficient permeability of the tear passages by preliminary injection of harmless solutions of cocaine or sterile water. In the event that an accident takes place in spite of all these precautions, an emergency operation should be performed at once, consisting in a large and deep incision in the region of the inner angle.

KERATITIS PUNCTATA DUE TO FILARIASIS (Lantern Slides). DR. MARBAIX, Tournay, Belguim, and DR. APPELMANS, Louvain, Belgium.

The interesting observation here is that of a parasitic origin of a punctate keratitis in a European woman who had lived in the Belgian Congo for six years and had been back in France for two. The decision as to the parasitic origin was based on eosinophilia, cutaneous reactions of prurigo and urticaria and finally the finding of microfilariae in the bulbar conjunctiva. They were of the variety known as Onchocerca volvulus, a species widely distributed in Western and Central Africa and transmitted by Glossina palpalis and by Simulium demnosum. This variety causes subcutaneous fibrous tumors and is also found in patients with elephantiasis in the Congo. In this case there was not much more than slight hyperemia of the conjunctiva. There were no subcutaneous nodules and no microfilariae in the blood. Treatment with emetine—which must, by the way, be handled carefully—relieved the pruritus, the cutaneous lesions, the conjunctival congestion and the photophobia.

VACCINIAL PUSTULE OF THE CORNEA. DR. MARIN-AMAT, Madrid, Spain.

A pediatrician was struck in the left eye by a splinter of glass when he broke a tube of lymph to vaccinate an infant. He was examined by me the next day, but there was nothing to be seen except a very slight general superficial ocular irritation, and, especially, there was no sign of corneal involvement. On the eighth day after the injury a true vaccinial pustule made its appearance at the center of the cornea, and there were marked symptoms of local and constitutional reaction. In the course of the next few days the ulcer progressed in extent as well as in depth until it occupied almost all of the cornea and produced a large abscess in the stroma without, however, causing any hypopyon. There was, besides, intense iridocyclitis. After a slow course, lasting five months, it was possible to save the eye, but an extensive and dense leukoma occupies almost all of the cornea and prevents vision. As this leukoma is flat and there is no increased intra-ocular tension I have hopes of restoring some vision later on by iridectomy. The present knowledge of this important subject is discussed in my paper. I am inclined to believe that the human cornea still presents special sensitivity to the virus of vaccinia even after the subject has been immunized by vaccine introduced cutaneously, because this ocular tissue has not taken part in the general immunization of the organism.

DIPHTHERITIC CONJUNCTIVITIS WITHOUT FALSE MEMBRANE. DR. HAAS, Paris.

The paper concerns four cases of diphtheria of the throat and nose which had not been recognized. Diphtheria without a false membrane is noted in the classic descriptions, but one does not generally think of this when involvement of the fauces is absent or when it appears in a different form from that of angina with a false membrane. In these cases the diagnosis was made solely as a result of ocular examination. One patient had nasal diphtheria with a false membrane; another, nasal diphtheria without a membrane; another, diphtheritic sore throat, angina

of the lacunar type, i. e., of innocent aspect like tonsillitis; the fourth, a child, had purely conjunctival diphtheria with heredosyphilitic septicemia. The principal clinical signs of these conjunctivitides were slight edema of the eyelids, a livid color of the skin of the lid, a violet tone of the lower fornix and a very scanty secretion, which was grayish or purely lacrimal. There were, in addition, swelling of the preauricular and submaxillary glands of varying degree but always accompanied by some "pastiness," little or no fever, pallor and marked general depression of the patient. Serotherapy should be instituted at the earliest possible moment and continued until not only the conjunctivae but, above all, the nasopharynx and the general condition return to normal.

RESISTANCE OF THE CORNEA TO HEAT (Lantern Slides). DR. L. COPPEZ, Brussels, Belgium.

In this preliminary study data are given on the effects of application of the pyrometric electrode to the cornea of the rabbit, i. e., of diathermic coagulation under thermic control. The electrode is applied cold and the current increased until the desired temperature is reached in thirty seconds. Under these conditions the rabbit's cornea stands very well a temperature of from 45 to 60 C. At this degree slight clouding of the cornea is noted, which disappears in twenty-four hours. At 65 and 70 C. the opacity is more marked and runs its course in ten days, leaving a slight macula. In order to have a standard of comparison I studied the effects of actual cauterization under the same conditions. For this purpose the pyrometric electrode was modified so that it was, in fact, a pyrometric cautery. Applied at the same temperatures, this heater caused necrotic opacities of the rabbit's cornea, which were marked and out of all proportion to those caused by diathermy. Stress is laid on the practical interest of pyrometric diathermic coagulation of the cornea, and attention is called to the vast experimental field opened to an instrument of precision such as the pyrometric cautery.

GLAUCOMATOUS DISSOCIATION OF CORNEAL EPITHELIUM (Lantern Slides.) DR. REDSLOB, Strasbourg.

In the course of marked intra-ocular hypertension two varieties of corneal opacity are noted:

1. Evanescent homogeneous clouding, which may come and go, disappearing instantaneously, as proved by experiments on rabbits. This clouding is not to be attributed to edema, as fluid could not diffuse or circulate through the stroma of the cornea with sufficient rapidity to produce this optical phenomenon. Rather, it is due to a disturbance of the topographic relations, a twisting out of place (*décalage*) of the lamellae of the substantia propria of the cornea, the regular arrangement of which is an important factor in assuring the transparency of that medium. This *décalage* causes irregularities of reflection and refraction; the originally uniform cornea becomes a "heterogeneous" medium, and the optical result is opacity.

2. Opacity accompanied by irregularities, rugosities, on the surface of the cornea, which appears as if covered with dew. These changes

persist for some time after the intra-ocular tension has become normal or almost normal. Histologic examination of this glaucomatous dissociation of corneal epithelium has enabled me to elucidate the mechanical process in the pathogenesis of this opacity. The liquid has made its way into the layer of the anterior epithelium owing to lesions in the endothelium. The lamellae of the stroma and of Bowman's membrane offer no resistance to the passage of a liquid. The case is quite different with the superficial layer of the anterior epithelium, which forms a solid barrier, forcing the liquid to accumulate between the basal cells.

KERATOPLASTY IN A PATIENT WITH FAMILIAL CORNEAL DEGENERATION. DR. FRANCESCHETTI and DR. KIEWE, Geneva, Switzerland.

No abstract was submitted.

HISTOLOGIC AND CLINICAL STUDY OF A NEVOCANCER OF THE CARUNCLE. DR. TERRIEN and DR. P. VEIL, Paris.

In spite of apparently radical extirpation at a very early stage the cancer recurred less than two months later. Application of radium was found to be of no avail. Complete exenteration of the orbit with removal of the eyelids was refused at first and could be carried out only rather late. This measure was followed by metastasis to the spine, resulting in death less than one year after the beginning of the disease. Histologic examination of the primary neoplasm showed criteria of nevus in the form of segregation, thecae and cellular abnormalities. The intra-orbital tumor presented an "endocrine" aspect, with areas of necrosis. Impregnation with silver nitrate showed melanophores and melanoblasts. Stress is laid on the rarity of new growths of this type, the defined diagnosis of which can be made only on histologic examination.

At the conclusion of this session there was a general meeting of the International Association for the Prevention of Blindness and of the International Organization Against Trachoma.

Second Session, May 12

ROENTGENOGRAPHY IN OPHTHALMOLOGY. DR. EDOUARD HARTMANN, Paris.

A translation by Dr. S. R. Gifford will be published separately.

DISCUSSION

DR. DOR: In 1916 I worked out a procedure for the roentgenographic localization of intra-ocular foreign bodies. In Germany Holzknecht published his quite similar method at almost the same time. This technic, which should be called the Dor-Holzknecht method, is absolutely satisfactory and is much simpler and cheaper than any of the others, which without exception require complicated and costly apparatus.

(The discussion of the article on roentgenography in ophthalmology was followed by a visit to the official exposition of instruments and their demonstration.)

Third Session, May 13

FLOATING BODIES IN THE ANTERIOR CHAMBER WITH MOTILITY DUE TO ACCOMMODATION. DR. POLLIOT, Besançon.

In two patients with coloboma of the iris, traumatic in one and congenital in the other, I noted in the anterior chamber floating bodies, some granular and others threadlike. These bodies moved very rapidly under an evident impulse of accommodation. They were thrown forward when accommodation relaxed for distance and backward when there was focusing for the near point. The movements were extremely rapid. In a subject with a normal iris a floating filament was displaced from behind forward under the same conditions, but the communicated motion was sensibly slower. This patient was 40 years of age, and the lowering of accommodation with age probably accounted for the less vigorous, less rapid motion communicated to the floating body in the anterior chamber. The two previously mentioned subjects were decidedly younger. Finally, in a young girl with astigmatism and a normal iris the threads in the anterior chamber were not displaced under the influence of accommodation. These movements certainly indicate a current in the surrounding aqueous. They might be explained by the forward projection of the anterior surface of the lens associated with accommodation or with the deepening of the anterior chamber toward the filtration angle focusing for near work. But the classic authorities tell one that the anterior crystalloid is projected forward only 0.5 mm. at most. So slight a displacement hardly explains the rush of aqueous shown by the rapid motion imparted to the floating bodies.

OCULAR TUBERCULOSIS OF INTRATHORACIC SOURCE (Lantern Slides). DR. WERDENBERG, Davos, Switzerland.

Ocular tuberculosis, especially that in the form of uveitis, is one of the most frequent causes of blindness. The etiologic diagnosis is often little more than a surmise, a diagnosis of probability. The clinical basis of judgment and of treatment of ocular tuberculosis is the ensemble of all the symptoms. It is, in fact, a qualitative decision and requires definite knowledge of:

1. The three principal "typical" forms of ocular tuberculosis (iridocyclitis), namely, the exudative, the productive and the fibrous. The fact that there are differences in specific sensitivity completes the knowledge of this point.

2. The most common source of ocular tuberculosis, the thoracic lymph nodes (hilar and mediastinal), as a focus of bacteremia and of ocular recurrence. A study of 600 roentgenograms of the chest was made. It was found that in 60 per cent of the patients there were mild symptoms of lymph node or pulmonary involvement; in 30 per cent, moderately grave lesions; in 10 per cent, serious lesions, with antagonism and parallelism between the ocular and the pulmonary condition. Technically perfect roentgenography is essential in this study.

3. The manifest symptoms of general tuberculous infection.

The object of therapy is, of course, to cure the ocular tuberculosis and to cure the source of infection. This implies a general constitution-

invigorating regimen, with climatic and altitude therapy as well as local treatment. The demonstrations include the exudative and the productive form of iridocyclitis tuberculosa and the intrathoracic source, tuberculous adenopathy of the hilus and miliary tuberculosis of the lung.

FIXATION OF THE EYE IN OPERATIONS ON THE GLOBE. DR. TOULANT, Algiers.

No abstract was submitted.

MERCUROCHROME STERILIZATION OF THE CONJUNCTIVA BEFORE AND AFTER OPERATION FOR CATARACT. DR. MARIN-AMAT, Madrid, Spain.

A 4 per cent solution of mercurochrome in doubly distilled water has been used in sterilizing infected conjunctivae, which are notoriously difficult if not impossible to sterilize with the usual antiseptics or even with the corresponding antivirus. After several months of personal study, numerous observations, laboratory findings and operations with favorable results I have adopted this procedure as an obligatory routine in my clinics at the Hôpital Provincial of Madrid. In my casuistics I published eight of the one hundred and fifty or more observations corresponding to infections with the three commonest micro-organisms, namely, staphylococci, streptococci and pneumococci as well as with the bacillus of conjunctival xerosis; in all of these infections instillation of solutions of mercurochrome produced absolute sterility of the conjunctiva. This made it possible to operate successfully in a number of cases in which surgical intervention would otherwise have been absolutely contraindicated by the pathologic condition of the conjunctiva. The antiseptic procedures were extended so as to apply also to sterilization of the conjunctival sac in postoperative dressings and even during operation in those cases in which this was indicated. I am of the opinion that there is no ocular antiseptic to equal this one.

CLINICAL EVOLUTION OF LENTICULAR OPACITIES. DR. CHARLES ROCHE, Marseilles.

I have previously called attention to the opacity which remains for an indefinite period localized at the center of the lens, the nuclear cataract. Although not densely opaque, it interferes considerably with vision. I now describe another variety of cataract, which I have observed so far mainly in females (forty-six females and three males). This I call "radiating opacification." It remains localized in the periphery and does not progress. As it does not markedly affect vision it is generally overlooked except on the occasion of an examination, i. e., of dilation of the pupil, for some other ocular disease.

CYCLODIALYSIS; TECHNIC; PROGNOSIS; INDICATIONS (Lantern Slides). DR. SAINT-MARTIN, Toulouse.

This operation is almost unknown in France. However, it deserves to be taken into serious consideration on account of its uniformly benign nature and its effectiveness in all forms of glaucoma. The operation

consists essentially in disinserting a portion of the ciliary body and establishing thus a communication of the subchoroidal spaces with the anterior chamber. Objection has been made that the effect of this operation is transitory. However, in following up seventy-four cases for over a year I found that intra-ocular tension had been normalized in 82 per cent. If setbacks occur, the operation can be repeated several times. Furthermore, it does not interfere with the correct execution eventually of a sclerecto-iridectomy (Lagrange). The principal statistical publications from Central Europe are uniformly optimistic. Hence, frequent and, above all, early recourse to this procedure appears strongly indicated when medical treatment, local and general, proves powerless to check the advance of the glaucomatous process, and especially when circumstances make it difficult or impossible to exercise control over the patient and do not lend themselves to regularly and frequently repeated examinations.

(*To be concluded*)

Book Reviews

Memorandum Book of a Tenth-Century Oculist. A Translation of the Tadhkirat of Ali ibn Isa of Baghdad (cir. 940-1010 A. D.), the Most Complete, Practical and Original of All the Early Textbooks on the Eye and Its Diseases. First English edition. By Dr. Casey A. Wood. Price, $8. Pp. 232, with 21 illustrations. Chicago: Northwestern University, 1936.

Wood in 1927 published an English edition of the first *printed* work on ophthalmology, "De oculis," etc., by Grassus, published in Ferrara in 1474. Now in his eightieth year he gives us in a like de luxe edition an English version of the most complete early *written* treatise on the eye—the "Tadhkirat" of Ali ibn Isa. Acknowledgment of assistance is accorded to many scholars abroad and at home, while the text is based chiefly on the German version of Hirschberg and Lippert.

It may not be amiss to devote a little space first to the source and development of Arabic medical literature in general. The great bulk of this literature was written between 700 and 1100 A. D. (the Mohammedan period) and was based on the teachings of Galen, who was born in Pergamos in 130 A. D. Galen, a student of Hippocrates and a physician in Rome, assembled in his voluminous Greek writings all that was known of medicine in his day, and his doctrines held high place in medical thought for more than a thousand years.

After the Roman Empire crumbled, the Arabic empire in the seventh century spread west to Egypt, Northern Africa and Spain and north to Persia, Iraq, Syria, Armenia and Asia Minor. When Egypt was invaded, scholars began to translate into Arabic the Greek manuscripts found in Alexandria. And soon after, Christians from Spain in the West to Persia in the East taught Greek medicine to the Arabs and translated Greek works into Arabic. Later a hundred Christians, Jews and Arabs systematized Greek medical knowledge, added to it chiefly in the fields of chemistry and botany, extended clinical observation and produced through four centuries a great mass of Arabic medical literature. Still later, Arabic treatises were in turn translated into Latin, and the torch of Greek learning was carried through the darkness of the Middle Ages.

Two outstanding figures in Arabic medicine were Hunain and Avicenna. Hunain, a Christian Arab, was born in 809 A. D. and lived in Bagdad. He translated the writings of Hippocrates, Aristotle and Galen into Arabic and wrote many medical works, including the noteworthy "Ten Treatises on the Eye," which made him famous.

Ibn Sina (in Latin, Avicenna), an Arabian physician and philosopher, was born in 980 A. D. near Bokhara. He systematized and classified the knowledge of his day and, basing his studies on the works of Aristotle, Galen and Hunain, wrote the "Canon of Medicine," which made him the foremost medical authority both in the East and in the West for five hundred years.

Finally, in the late period of the Renaissance, studies in anatomy and physiology which had lain dormant since the Greek days were taken up anew, scientific observation began to prevail over philosophic speculation, and the evolution of modern medicine commenced.

In our times interest in this largely forgotten Arabic lore was revived by Dr. Lucien Leclerc, who had access to the Arabic treasures in the Bibliotèque national of Paris and in the Escorial. Leclerc translated a number of the medical treatises into French and later wrote his great book of 1,100 pages called "Histoire de la médicine arabe," published in Paris in 1876. In 1902 a German translation of the ophthalmology of Avicenna was published by Hirschberg and Lippert. Later, translations of other ophthalmologic texts were made by Hirschberg and his associates, and the entire subject of Arabic ophthalmology was discussed in Hirschberg's history of medicine in the Graefe-Saemisch "Handbuch der gesamten Augenheilkunde." Writings in English on Arabic medicine by Osler and others are based chiefly on the books of Leclerc and Hirschberg.

Reverting to this important tenth-century memorandum book of ophthalmology, admirably translated, annotated and commented on by Wood, the reader is struck by the fact that the descriptions of external diseases and their treatment seem so modern, so like those of the books written just before the ophthalmoscope came into use. For example, the chapter on trachoma consists of four pages in which several varieties or stages of the disease are discussed in detail. Emollients are prescribed for certain forms, and the oxides of iron and of copper with a dozen other mineral and vegetable agents for other forms, and scarification with a knife or compression with a smooth instrument are the surgical procedures advised.

The chapter on cataract takes up ten pages. A number of varieties are distinguished, and the operation discussed is that of reclination, which was described by Celsus at the time of Christ and was used universally until Daviel devised extraction two centuries ago.

The book stresses throughout the need for purgation, special diets and attention to the general health. Painful operations are to be performed only under deep narcosis. Narcosis was well known, for Dioscorides, the Greek physician and botanist, who about the first century wrote an extraordinary treatise on plants, "De materia medica," described the narcotic and anesthetic properties of the various sorts of mandragora and of hyoscyamus. Such plants, alone or with the poppy, were used through the ages for surgical anesthesia, to be discarded and forgotten later and then taken up again for twilight sleep in the present generation.

One cause of failure of vision is compression of the optic nerves resulting from distention of the cerebral ventricles; this requires special study. The author, however, does not mention the operation for cranial decompression, which was described by Hippocrates, who was born in 460 B. C. In this connection it might be added that Hirschberg, in the Graefe-Saemisch "Handbuch der gesamten Augenheilkunde," in 1899 declared that the operation described by Hippocrates of trephining the skull and releasing the accumulated fluid to cure certain kinds of blindness, had never failed to provoke astonishment or laughter in physicians throughout the centuries. Yet a report in 1875 that the trephining of

a patient with otitic epidural abscess had restored lost vision and also subsequent studies on papilledema induced him to believe that there might be some merit in this operation.

Perhaps the principal value of this book to the student today lies in the fact that it reveals the antiquity of much knowledge believed to be new and the importance of much ancient knowledge now generally forgotten.

WARD A. HOLDEN.

Le décollement de la rétine et son traitement. By F. Terrien, Prosper Veil and M. A. Dollfus. Price, 40 francs. Pp. 163, with 45 plates, 4 in color. Paris: Masson & Cie, 1936.

The authors feel that there is a regrettable hesitancy on the part of ophthalmologists in grasping the possibility of the proper and early treatment of retinal detachment, which is based on insufficient enthusiasm or unwarranted skepticism. An experience of five years in the large and excellent ophthalmic clinic of the Hôtel-Dieu in Paris has given them the opportunity of studying the various methods of operating and their indications, which are described in this practical manual. The book begins with a clinical study of retinal detachment and a description of the preliminary symptoms; the appearance of the detachment is illustrated by beautiful reproductions in color. The clinical varieties of retinal holes and tears are then portrayed, grouped in the following types: V-shaped tears with a flap, round holes, linear tears and oral disinsertions. These, with the exception of the disinsertions, occur most frequently in the superotemporal quadrant. The authors believe that the fundamental cause of retinal detachment is a pathologic process in the equatorial part of the choroid, or other changes in the anterior segment of the eyeball resulting from the wear and tear of the tissue, ending in cystic degeneration and tears in the retina, rather than vitreous traction. The indications and contraindications for operation and the methods of examination for the discovery and localization of the hole are then taken up in turn.

In regard to treatment, the authors state that as the rôle of the retinal tear in the pathogenesis of detachment must be accepted, the necessity of its obliteration is evident. Then follow a description of the method of Gonin (ignipuncture); the method of Guist (chemical cauterization of the choroid); diathermocoagulation, which is at present the most practical method (used by Larsson, Weve, Šafář and Coppez), and galvanocauterization (used by Rollet, Paufique, Veil and Vogt).

The advantages of the various methods are given as follows: Juxtachoroidal galvanocauterization (Veil) is easily applied and has a simple instrumentation allowing good ophthalmoscopic control. The galvanocautery used in this method has a very fine and pointed needle which can be introduced through the sclera deep enough to irritate the choroid without perforating. The pressure of the globe is not reduced, and the procedure may be repeated many times; to evacuate the subretinal fluid one or two perforating punctures are made. Diathermocoagulation, both surface and perforating, can also be applied to posterior tears, in the case of large holes and disinsertions, or in certain cases both methods can be combined. The Gonin obliterating thermopuncture is reserved for small and single holes which are readily accessible.

In the after-treatment the dressing is replaced by the stenopaic spectacles on the seventh day; the patient begins to sit up in bed on the twelfth day, and he is allowed out of bed on from the fourteenth to the sixteenth day. Relapses due to new tears are observed in the first weeks after the operation; no relapses have been seen after three or four months.

ARNOLD KNAPP.

The Prevention and Correction of Reading Difficulties. By Emmet Albert Betts, Director of Teacher Education, State Normal School, Oswego, N. Y. Pp. 402, with a number of photographs of apparatus and appliances. Evanston, Ill.: Row, Peterson & Company, 1936.

This book, dedicated to misunderstood children and addressed to teachers, takes into account the extensive recent periodical literature on difficulty in reading but seems in the main to stem from two books: "The Psychology of Reading and Spelling," by Gates, published in 1922, and "The Psychology and Pedagogy of Reading," by Huey, published in 1924. The latter is known to the reviewer as an instructive treatise containing the results of much personal research.

The child retarded in reading may be of low intelligence generally, or he may have specific learning disability in reading, while ranking high in mathematics and kindred studies. From 8 to 15 per cent of the school population presents evidences of specific reading disability. Usually there exists a complex of difficulties, emotional, physical and pedagogic, any of which might be tolerated alone. With the determination of the causes of his difficulties and their correction, as far as possible, the child may be taught to read normally.

A consideration of specific retardation in its varieties, its underlying causes, its relation to growth and education, its prevention and its correction, together with an account of the equipment and methods of teaching in the reading clinic of the author's school, makes up the bulk of the volume. There are special chapters on eye and hand preference, movements of the eyes, the work of the eyes and the mechanics of reading materials, and on hearing. An appendix of seventy-five pages is perhaps the more original part of the book. It deals with the author's "Ready to Read" tests, which are designed to reveal the nature of the child's disabilities and suggest measures for their correction. The printed cards employed are distributed by the Keystone View Company, Meadville, Pa. In this section Betts describes visual readiness tests, auditory readiness tests, visual sensation and perception tests, oculomotor and perception tests, and also supplementary tests of fusion, reliability, agility of visual blending and ocular coordination for context reading.

The book is intelligibly written, contains a glossary of the scientific terms used and a full index and would seem to fulfil admirably its intended purpose.

WARD A. HOLDEN.

Directory of Ophthalmologic Societies *

INTERNATIONAL

International Association for Prevention of Blindness

President: Prof. F. de Lapersonne, 217 Faubourg St. Honoré, Paris.
Secretary-General: Prof. M. Van Duyse, Université de Gand, Gand, Prov. Ostflandern, Belgium.

International Ophthalmologic Congress

Secretary: Dr. E. Marx, Costzeedijk 316, Rotterdam, Holland.
Place: Cairo. Time: December 1937.

FOREIGN

British Medical Association, Section on Ophthalmology

President: Dr. P. E. H. Adams, 6, Holywell, Oxford.
Secretary: Dr. Thomasina Belt, 13, Mitchell Ave., Jesmond, Newcastle-on-Tyne.
Place: Oxford. Time: July 22-24, 1936.

Ophthalmology Society of Bombay

President: Dr. D. D. Sathaye, 127 Girgaum Road, Bombay 4.
Secretary: Dr. H. D. Dastur, Dadar, Bombay 14.
Place: H. B. A. Free Ophthalmic Hospital, Parel, Bombay 12. Time: First Friday of every month.

Ophthalmological Society of the United Kingdom

President: Mr. R. Foster Moore, 53, Harley St., London, 1.
Secretary: Miss Ida Mann, 7, Wimpole St., London, 1.

Oxford Ophthalmological Congress

Master: Dr. C. G. Russ Wood, Hill House, Abberbury Rd., Iffley, Oxford, England.
Hon. Secretary-Treasurer: Dr. F. A. Anderson, 12 St. John's Hill, Shrewsbury, England

Royal Society of Medicine, Section of Ophthalmology

President: Dr. Ransom Pickard, 31, East Southernhay, Exeter, England.
Secretary: Dr. A. Rugg-Gunn, 35, Harley St., London, W. 1.

Société Française d'Ophthalmologie

Secretary: Dr. René Onfray, 6 avenue de la Motte Picquet, Paris 7è.

Society of Swedish Ophthalmologists

President: Prof. F. Berg, Uppsala, Sweden.
Secretary: Dr. K. O. Granström, Södermalmstorg 4 III tr., Stockholm, Sö., Sweden.

German Ophthalmological Society

President: Prof. Lohlein, Jena.
Secretary: Prof. A. Wagenmann, Heidelberg.

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* Secretaries of societies are requested to furnish the information necessary to make this list complete and to keep it up to date.

CHINESE OPHTHALMOLOGICAL SOCIETY OF PEIPING

President: Dr. H. T. Pi, Peiping Union Medical College, Peiping.
Secretary: Dr. C. K. Lin, 180 Hsi-Lo-yen, Chienmeng, Peiping.
Place: Peiping Union Medical College, Peiping. Time: Last Friday of each month.

TSINAN OPHTHALMOLOGICAL SOCIETY

Chairman: Dr. Eugene Chan, Cheeloo University School of Medicine, Tsinan, Shantung.
Place: Cheeloo University School of Medicine. Time: Last Thursday of alternate months.

NATIONAL

AMERICAN MEDICAL ASSOCIATION, SCIENTIFIC ASSEMBLY, SECTION ON OPHTHALMOLOGY

Chairman: Dr. William L. Benedict, 102 Second Ave., S. W., Rochester, Minn.
Secretary: Dr. Parker Heath, 1553 Woodward Ave., Detroit.
Place: Atlantic City. Time: June 7-11, 1937.

AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Frank E. Burch, 408 Peter St., St. Paul.
Executive Secretary-Treasurer: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.
Place: New York. Time: Sept. 26 to Oct. 3, 1936.

AMERICAN OPHTHALMOLOGICAL SOCIETY

President: Dr. Harry Friedenwald, 1212 Eutaw Pl., Baltimore.
Secretary-Treasurer: Dr. J. Milton Griscom, 2213 Walnut St., Philadelphia.

NATIONAL SOCIETY FOR THE PREVENTION OF BLINDNESS

President: Mr. William Fellowes Morgan, 50 W. 50th St., New York.
Managing Director: Mr. Lewis H. Carris, 50 W. 50th St., New York.

SECTIONAL

NEW ENGLAND OPHTHALMOLOGICAL SOCIETY

President: Dr. James J. Regan, 520 Commonwealth Ave., Boston.
Secretary-Treasurer: Dr. William P. Beetham, 5 Bay State Road, Boston.
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time: 8 p. m., third Tuesday of each month from November to April, inclusive.

PACIFIC COAST OTO-OPHTHALMOLOGICAL SOCIETY

President: Dr. A. J. Ridges, Walker Bldg., Salt Lake City, Utah.
Secretary-Treasurer: Dr. Frederick C. Cordes, 384 Post St., San Francisco.
Place: Salt Lake City, Utah. Time: May 24-27, 1937.

PUGET SOUND ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. L. H. Klemptner, 509 Olive St., Seattle.
Secretary-Treasurer: Dr. Purman Dorman, Virginia Mason Hospital, Seattle.
Place: Seattle. Time: January 1937.

ROCK RIVER VALLEY EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. A. H. Pember, 500 W. Milwaukee St., Janesville, Wis.
Secretary-Treasurer: Dr. W. H. Elmer, 321 W. State St., Rockford, Ill.
Place: Rockford, Ill., Janesville or Beloit, Wis. Time: Third Tuesday of each month.

SAGINAW VALLEY ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Robert Griswell, 707 Washington Ave., Bay City, Mich.
Secretary-Treasurer: Dr. W. K. Slack, 308 Eddy Bldg., Saginaw, Mich.
Place: Saginaw, Mich., or Bay City, Mich. Time: Second Tuesday of each month, except July and August.

SIOUX VALLEY EYE AND EAR ACADEMY

President: Dr. L. H. Hohf, Yankton, S. D.
Secretary-Treasurer: Dr. J. C. Decker, Francis Bldg., Sioux City, Iowa.

SOUTHERN MEDICAL ASSOCIATION, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. William A. Wagner, 914 American Bank Bldg., New Orleans.
Secretary: Dr. O. M. Marchman, Medical Arts Bldg., Dallas, Texas.

SOUTHWESTERN MICHIGAN TRIOLOGICAL SOCIETY

President: Dr. O. B. McGillicuddy, 1908 Capitol Band Tower, Lansing, Mich.
Secretary-Treasurer: Dr. Maurice C. Loree, 120 W. Hillsdale St., Lansing, Mich.
Time: Third Thursday of alternate months.

WESTERN PENNSYLVANIA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Leslie R. Hazlett, 100 S. Main St., Butler.
Secretary-Treasurer: Dr. C. W. Beals, 41 N. Brady St., DuBois.

STATE

COLORADO OPHTHALMOLOGICAL SOCIETY

President: A presiding officer is selected for each meeting alternately until all members have served.
Secretary: Dr. Edna M. Reynolds, 227, 16th St., Denver.
Place: Capitol Life Building, Denver. Time: 7:30 p. m., third Saturday of the month, October to April, inclusive.

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON EYE, EAR, NOSE AND THROAT

President: Dr. Walter L. Hogan, 750 Main St., Hartford.
Secretary-Treasurer: Dr. Shirley H. Baron, 309 State St., New London.
Time: May, November.

EYE, EAR, NOSE AND THROAT CLUB OF GEORGIA

President: Dr. B. H. Minchew, 701 Elizabeth St., Waycross, Ga.
Secretary-Treasurer: Dr. Edward S. Wright, 1001 Medical Arts Bldg., Atlanta, Ga.

INDIANA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. J. R. Dillinger, French Lick.
Secretary: Dr. Frederick V. Overman, 705 Hume-Mansure Bldg., Indianapolis.

IOWA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Edwin Cob, 307 Masonic Temple, Marshalltown.
Secretary-Treasurer: Dr. O. L. Thorburn, 213½ Main St., Ames.
Place: Marshalltown. Time: September 1936.

MICHIGAN STATE MEDICAL SOCIETY, SECTION OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Parker Heath, 1553 Woodward Ave., Detroit.
Secretary: Dr. D. R. Heetderks, 26 Sheldon Ave., S. E., Grand Rapids.

MINNESOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. H. E. Binger, 350 St. Peter St., St. Paul.
Secretary-Treasurer: Dr. Walter E. Camp, Medical Arts Bldg., Minneapolis.

MONTANA ACADEMY OF OTO-OPHTHALMOLOGY

President: Dr. Edward S. Murphy, Northern Pacific Hosp., Missoula.
Secretary: Dr. A. W. Morse, 507 Phoenix Bldg., Butte.

NEW JERSEY STATE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY, OTOLOGY AND RHINOLARYNGOLOGY

Chairman: Dr. C. Coulter Charlton, 124 S. Illinois Ave., Atlantic City.
Secretary: Dr. H. L. Harley, 124 S. Indiana Ave., Atlantic City.

NEW YORK STATE MEDICAL SOCIETY, EYE, EAR, NOSE AND THROAT SECTION

Chairman: Dr. John F. Fairbain, 925 Delaware Ave., Buffalo.
Secretary: Dr. Walter S. Atkinson, 168 Sterling St., Watertown.

NORTH CAROLINA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Burton W. Fassett, Geer Bldg., Durham.
Secretary-Treasurer: Dr. Casper W. Jennings, 332 N. Elm St., Greensboro.
Place: Durham. Time: October 1936.

NORTH DAKOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Trygve Oftedal, 55½ Broadway, Fargo.
Secretary-Treasurer: Dr. F. L. Wicks, 514 6th St., Valley City.

OREGON ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. A. B. Dykman, Medical Dental Bldg., Portland.
Secretary-Treasurer: Dr. Andrew J. Browning, 418 Mayer Bldg., Portland.
Place: Good Samaritan Hospital. Time: Third Tuesday of each month.

RHODE ISLAND OPHTHALMOLOGICAL AND OTOLOGICAL SOCIETY

Acting President: Dr. Nathan Bolotow, 108 Waterman St., Providence.
Secretary and Treasurer: Dr. Gordon J. McCurdy, 122 Waterman St., Providence.
Place: Rhode Island Medical Library. Time: 8:30 p. m., second Thursday in October, December, February and April.

SOUTH CAROLINA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. R. E. Houston, 103 E. North St., Greenville.
Secretary: Dr. J. W. Jervey Jr., 101 Church St., Greenville.

TENNESSEE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. W. W. Potter, 601 Walnut St., Knoxville.
Secretary-Treasurer: Dr. W. D. Stinson, 248 Madison Ave., Memphis.

TEXAS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. T. E. Fuller, 100 W. Board St., Texarkana, Texas.
Secretary: Dr. O. M. Marchman, 1719 Pacific Ave., Dallas.
Time: Dec. 4 and 5, 1936. Place: Fort Worth.

UTAH OPHTHALMOLOGICAL SOCIETY

President: Dr. V. P. White, 143½ S. Main St., Salt Lake City.
Secretary-Treasurer: Dr. E. B. Fairbanks, Boston Bldg., Salt Lake City.
Time: Third Monday of each month.

VIRGINIA SOCIETY OF OTO-LARYNGOLOGY AND OPHTHALMOLOGY

President: Dr. Emory Hill, 501 E. Franklin St., Richmond.
Secretary-Treasurer: Dr. George G. Hankins, Medical Arts Bldg., Newport News.

WEST VIRGINIA STATE MEDICAL ASSOCIATION, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. F. O. Marple, First Huntington National Bank Bldg., Huntington.
Secretary: Dr. J. E. Blaydes, First National Bank, Bluefield.

LOCAL

ACADEMY OF MEDICINE OF NORTHERN NEW JERSEY, SECTION ON EYE, EAR, NOSE AND THROAT

President: Dr. B. E. Failing, 31 Lincoln Park, Newark, N. J.
Secretary: Dr. A. Russell Sherman, 671 Broad St., Newark, N. J.
Place: 91 Lincoln Park South, Newark. Time: 8:45 p. m., second Monday of each month, October to May.

ATLANTA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. William O. Martin Jr., 478 Peachtree St., Atlanta, Ga.
Secretary: Dr. A. V. Hallum, 478 Peachtree St., Atlanta, Ga.
Place: Academy of Medicine, 38 Prescott St. Time: Second Friday of each month from October to May.

BALTIMORE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Jesse W. Downey Jr., 529 N. Charles St., Baltimore.
Secretary: Dr. Mary L. Small, 18 W. Read St., Baltimore.
Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to May.

BROOKLYN OPHTHALMOLOGICAL SOCIETY

President: Dr. Walter V. Moore, 1 Nevins St., Brooklyn.
Secretary-Treasurer: Dr. Mortimer A. Lasky, 1 Nevins St., Brooklyn.
Place: Kings County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday in February, April, May, October and December.

BUFFALO OPHTHALMOLOGIC CLUB

President: Dr. Thurber LeWin, 112 Linwood Ave., Buffalo.
Secretary-Treasurer: Dr. I. J. Koenig, 40 North St., Buffalo.
Time: Second Thursday of each month.

CHATTANOOGA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Each member, in alphabetical order.
Secretary: Dr. A. H. Benz, 706 Medical Arts Bldg., Chattanooga.
Place: Mountain City Club. Time: Second Thursday of each month from September to May.

CHICAGO OPHTHALMOLOGICAL SOCIETY

President: Dr. Robert B. Blue, 25 E. Washington St., Chicago.
Secretary-Treasurer: Dr. Thomas D. Allen, 122 S. Michigan Ave., Chicago.
Place: Medinah Michigan Avenue Club, 505 N. Michigan Ave. Time: Third Monday of each month from October to May.

Cincinnati Ophthalmic Club

Chairman: Each member, in rotation.
Secretary-Treasurer: Dr. E. R. Thomas, 819 Carew Tower, Cincinnati.
Place: Holmes Memorial Library, Cincinnati General Hospital. Time: 8:15 p. m., third Monday of each month except June, July and August.

Cleveland Academy of Medicine, Section of Ophthalmology and Otolaryngology

Chairman: Dr. A. D. Ruedemann, 2020 E. 93d St., Cleveland.
Secretary: Dr. Fred W. Dixon, 1029 Rose Bldg., Cleveland.
Place: Winton Hotel. Time: Fourth Friday of each month.

Cleveland Ophthalmological Club

Chairman: Dr. A. B. Bruner, 629 Euclid Ave., Cleveland.
Secretary: Dr. M. W. Jacoby, Hanna Bldg., Cleveland.

College of Physicians, Philadelphia, Section on Ophthalmology

Chairman: Dr. John Milton Griscom, 2213 Walnut St., Philadelphia.
Clerk: Dr. Alexander G. Fewell, 1924 Pine St., Philadelphia.
Time: Third Thursday of every month from October to April, inclusive.

Columbus Ophthalmological and Oto-Laryngological Society

Chairman: Dr. F. W. Thomas, 327 E. State St., Columbus, Ohio.
Secretary-Treasurer: Dr. H. D. Emswiler, 370 E. Town St., Columbus, Ohio.
Place: Athletic Club. Time: First Monday of each month.

Dallas Academy of Ophthalmology and Oto-Laryngology

President: Dr. Hugh L. McLaurin, 1719 Pacific Ave., Dallas, Texas.
Secretary: Dr. Maxwell Thomas, 1719 Pacific Ave., Dallas, Texas.
Place: Dallas Athletic Club. Time: 6:30 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

Des Moines Academy of Ophthalmology and Otolaryngology

President: Dr. E. G. Linn, 604 Locust St., Des Moines, Iowa.
Secretary-Treasurer: Dr. Grace Doane, 614 Bankers Trust Bldg., Des Moines, Iowa.
Time: 7:45 p. m., third Monday of every month, September to May.

Detroit Ophthalmological Club

Chairman: Members rotate alphabetically.
Secretary: Dr. Raymond S. Goux, David Whitney Bldg., Detroit.
Time: 6:30 p. m., first Wednesday of each month.

Eastern New York Eye, Ear, Nose and Throat Association

President: Dr. A. W. Greene, 148 Barrett St., Schenectady.
Secretary-Treasurer: Dr. Joseph L. Holohan, 317 State St., Albany.
Time: Third Wednesday in October, November, March, April, May and June.

Fort Worth Eye, Ear, Nose and Throat Society

President: Dr. T. L. Goodman, 602 W. 10th St., Forth Worth, Texas.
Secretary-Treasurer: Dr. Van D. Rathgeber, 1012 Medical Arts Bldg., Fort Worth.
Place: Medical Hall, Medical Arts Bldg. Time: 7:30 p. m., first Friday of each month except July and August.

Grand Rapids Eye, Ear, Nose and Throat Society

President: Dr. John H. McRae, 26 Sheldon Ave., S. E., Grand Rapids, Mich.
Secretary-Treasurer: Dr. Robert G. Laird, 307 Metz Bldg., Grand Rapids, Mich.
Place: Various local hospitals. Time: Third Thursday of alternating months, September to May.

Houston Academy of Medicine, Eye, Ear, Nose and Throat Section

President: Dr. Henry C. Haden, 1914 Travis St., Houston, Texas.
Secretary: Dr. George C. Farrish, 1625 Main St., Houston, Texas.
Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., second Thursday of each month from September to June.

Indianapolis Ophthalmological and Otolaryngological Society

President: Dr. J. C. Daniel, 23 E. Ohio St., Indianapolis.
Secretary: Dr. Kenneth L. Craft, 23 E. Ohio St., Indianapolis.
Place: University Club. Time: 6:30 p. m., second Thursday of each month from October to May.

Kansas City Society of Ophthalmology and Oto-Laryngology

President: Dr. H. B. Davis, 1101 Grand Ave., Kansas City, Mo.
Secretary: Dr. Byron Black, Professional Bldg., Kansas City, Mo.
Time: Third Thursday of each month from September to May. The November, January and March meetings are devoted to clinical work.

Long Beach Eye, Ear, Nose and Throat Society

Chairman: Dr. K. C. Brandenburg, 110 Pine Ave., Long Beach, Calif.
Secretary-Treasurer: Dr. Ben K. Parks, 619 Professional Bldg., Long Beach, Calif.
Place: Professional Bldg. Time: Last Wednesday of each month from October to May.

Los Angeles Society of Ophthalmology and Oto-Laryngology

President: Dr. William A. Boyce, 727 W. 7th St., Los Angeles.
Secretary-Treasurer: Dr. John P. Lordan, 2007 Wilshire Blvd., Los Angeles.
Place: Los Angeles County Medical Association Bldg., 1925 Wilshire Blvd. Time: 6:30 p. m., fourth Monday of each month from September to May, inclusive.

Louisville Eye, Ear, Nose and Throat Society

President: Dr. J. S. Bumgardner, Heyburn Bldg., Louisville, Ky.
Secretary-Treasurer: Dr. Max Bornstein, Heyburn Bldg., Louisville, Ky.
Place: Brown Hotel. Time: 6:30 p. m., second Thursday of each month from September to May, inclusive.

Medical Society of the District of Columbia, Section of Ophthalmology and Otolaryngology

Chairman: Dr. Arthur M. Zinkham, 815 Connecticut Ave., Washington.
Secretary: Dr. E. J. Cummings, 1835 I St., N. W., Washington.
Place: 1718 M St., N. W. Time: 8 p. m., third Friday of each month from October to April, inclusive.

Memphis Society of Ophthalmology and Otolaryngology

Chairman: Each member, in alphabetical order.
Secretary: Dr. R. O. Rychener, 130 Madison Ave., Memphis, Tenn.
Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month.

Milwaukee Oto-Ophthalmic Society

President: Dr. Hilmar G. Martin, 231 W. Wisconsin Ave., Milwaukee.
Secretary-Treasurer. Dr. Herbert G. Schmidt, 238 W. Wisconsin Ave., Milwaukee.
Place: University Club. Time: 6 p. m., second Tuesday of each month.

Minneapolis Ophthalmological Society

Chairman: Each member in alphabetical order.
Secretary: Dr. C. W. Rucker, 527 Medical Arts Bldg., Minneapolis.
Place: Hennepin County Medical Society rooms. Time: 6:30 p. m., fourth Monday of each month, October to May, inclusive.

Montgomery County Medical Society

Chairman: Dr. W. J. Blackburn, 663 Reibold Bldg., Dayton, O.
Secretary-Treasurer: Dr. F. J. Driscoll, 986 Reibold Bldg., Dayton, O.
Place: Van Cleve Hotel. Time: 6:30 p. m., bimonthly, first Tuesday from October to June, inclusive.

Montreal Ophthalmological Society

President: Dr. Stuart Ramsay, 1496 Mountain St., Montreal, Canada.
Secretary: Dr. J. Rosenbaum, 1396 St. Catherine St., West, Montreal, Canada.
Time: Second Thursday of October, December, February and April.

Nashville Academy of Ophthalmology and Otolaryngology

Chairman: Dr. Kate S. Zerfoss, 119, 7th Ave., N., Nashville, Tenn.
Secretary-Treasurer: Dr. Fowler Hollabaugh, Doctors Bldg., Nashville, Tenn.
Place: St. Thomas Hospital. Time: 8 p. m., third Monday of each month from October to June.

New Orleans Ophthalmological and Otolaryngological Society

President: Dr. R. H. Fisher, Chess and Checker Club, New Orleans.
Secretary-Treasurer: Dr. H. F. Brewster, 837 Gravier St., New Orleans.
Place: Eye, Ear, Nose and Throat Hospital. Time: Third Thursday of each month from October to June.

New York Academy of Medicine, Section of Ophthalmology

Chairman: Dr. John H. Dunnington, 30 W. 59th St., New York.
Secretary: Dr. LaGrand H. Hardy, 30 E. 40th St., New York.
Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

Omaha and Council Bluffs Ophthalmological and Oto-Laryngological Society

President: Dr. W. H. Stokes, 107 S. 17th St., Omaha.
Secretary-Treasurer: Dr. Delbert K. Judd, 1020 Medical Arts Bldg., Omaha.
Place: Omaha Club, 20th and Douglas Sts., Omaha. Time: 6 p. m., dinner; 7 p. m., program; third Wednesday of each month from October to May.

Passaic-Bergen Ophthalmological Club

President: Dr. E. C. Reynolds, 657 Main Ave., Passaic, N. J.
Secretary-Treasurer: Dr. T. A. Sanfacon, 80 Park Ave., Paterson, N. J.
Place: Paterson Eye and Ear Infirmary. Time: 9 p. m., last Friday of every month, except June, July and August.

Philadelphia County Medical Society, Eye Section

Chairman: Dr. Sidney L. Olsho, 235 S. 15th St., Philadelphia.
Secretary: Dr. Edmund B. Spaeth, 1930 Chestnut St., Philadelphia.
Time: First Thursday of each month from October to May.

Pittsburgh Ophthalmological Society

President: Dr. Glendon E. Curry, Westinghouse Bldg., Pittsburgh.
Secretary: Dr. George H. Shuman, Park Bldg., Pittsburgh.
Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

Pittsburgh Slit Lamp Society

President: Dr. W. W. Blair, 121 University Pl., Pittsburgh.
Secretary: Dr. George H. Shuman, Park Bldg., Pittsburgh.
Place: Falk Clinic. Time: 4 p. m., second Friday of every month, except June, July, August and September.

Richmond Ophthalmological and Oto-Laryngological Society

President: Dr. Robert H. Courtney, Professional Bldg., Richmond, Va.
Secretary: Dr. Richard W. Vaughan, Medical Arts Bldg., Richmond, Va.
Place: Westmoreland Club. Time: 6 p. m., second Monday of each month from October to May.

Rochester Eye, Ear, Nose and Throat Society

President: Dr. R. E. Elliott, 78 S. Fitzhugh St., Rochester, N. Y.
Secretary-Treasurer: Dr. Raphael Farber, 280 Monroe Ave., Rochester, N. Y.
Place: Rochester Medical Association, 113 Prince St. Time: 8 p. m., third Monday of each month from October to May.

St. Louis Ophthalmic Society

President: Dr. Carl T. Eber, 308 N. 6th St., St. Louis.
Secretary: Dr. W. M. James, 508 N. Grand Ave., St. Louis.
Place: Oscar Johnson Institute. Time: Clinical meeting 5:30 p. m., dinner and scientific meeting 6:30 p. m., fourth Friday of each month from October to April, inclusive, except December.

San Antonio Ophthalmolo-Oto-Laryngological Society

President: Dr. William D. Gill, 323 Medical Arts Bldg., San Antonio, Texas.
Secretary-Treasurer: Dr. Frank Steed, Nix Professional Bldg., San Antonio, Texas.
Place: Bexar County Medical Library. Time: 8 p. m., first Tuesday of each month from October to May.

San Francisco County Medical Society, Section on Eye, Ear, Nose and Throat

Chairman: Dr. Frank H. Rodin, 490 Post St., San Francisco.
Secretary: Dr. Louis F. Morrison, 490 Post St., San Francisco.
Place: Society's Building, 2180 Washington St., San Francisco.
Time: Fourth Tuesday of every month except May, June, July and December.

Shreveport Eye, Ear, Nose and Throat Society

President: Dr. John T. Crebbin, 624 Travis St., Shreveport, La.
Secretary-Treasurer: Dr. J. A. Wilkinson, Medical Arts Bldg., Shreveport, La.
Place: 1240 Texas Ave. Time: 7:30 p. m., first Monday of every month except July, August and September.

Spokane Academy of Ophthalmology and Oto-Laryngology

President: Dr. C. A. Veasey Jr., 407 Riverside Ave., Spokane, Wash.
Secretary: Dr. Philip B. Greene, Old National Bank Bldg., Spokane, Wash.
Place: Paulsen Medical and Dental Library. Time: 8 p. m., fourth Tuesday of each month except June, July and August.

Syracuse Eye, Ear, Nose and Throat Society

President: Dr. W. J. Werfelman Jr., 725 State Tower Bldg., Syracuse, N. Y.
Secretary-Treasurer: Dr. I. Herbert Katz, 212 Medical Arts Bldg., Syracuse, N. Y.
Place: University Club. Time: First Tuesday of each month except June, July and August.

Toronto Academy of Medicine, Section of Ophthalmology

Chairman: Dr. Samuel Mortimer Lyon, 122 Bloor St., W., Toronto.
Secretary: Dr. A. Lloyd Morgan, 86 Bloor St., West, Toronto.
Time: First Monday, November to April.

Washington, D. C., Ophthalmological Society

President: Dr. James M. Greear Jr., 1740 M St., N. W., Washington, D. C.
Secretary-Treasurer: Dr. Ernest Sheppard, 927 17th St., Washington, D. C.
Place: Episcopal Eye, Ear and Throat Hospital. Time: 8 p. m., first Monday in November, January, March and May.